FINANCING THE CONVERSION OF STEAMSHIPS

NEW YORK SEATTLE

MOTORSHIP

Devoted to Commercial and Naval Motor Vessels

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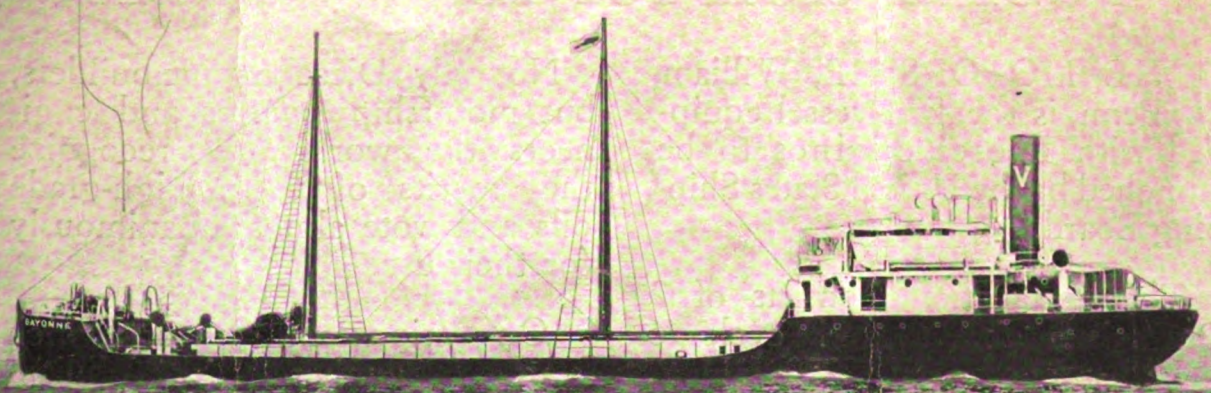
DIESEL MARINE ENGINES
FOR ALL CLASSES OF SHIPS



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EXCLUSIVE technical and non-technical articles on design, construction and operation of oil-engines and motorships by the world's foremost writers on marine engineering.

MOTORSHIP

PROFUSELY illustrated with photographic reproductions of the newest designs in international merchant motorship and Diesel-engine construction and auxiliary equipment.

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First Steps by the U. S. Shipping Board

Nineteen Steam-Driven Freighters Offered to Shipowners for Conversion to Diesel Power.

ON all sides the practical conversion plan outlined in last month's issue of "Motorship" has been given approval by builders and owners; some shipowners even going further than they think we apparently do, and recommend that the Shipping Board shall give the vessels without charge provided the "purchasers" undertake to instal Diesel-engines. Careful study of our plan, however, will reveal that in special cases where the cost of conversion is equal to the cost of a complete foreign-built motorship, the price of the hull would be practically nothing.

On another page of this issue the Board through the Emergency Fleet Corporation offers for sale nineteen steamers ranging from 3,500 to 11,850 tons deadweight to shipowners who will guarantee the installation of Diesel-propelling power-plants approved by the Fleet Corporation. No matter what arrangements the Board may desire to make with shipowners for the conversion of steamships the law requires that the vessels must be advertised and bids invited prior to their sale. There is not much time for shipowners to have conversion-plans worked out and secure prices on the Diesel plants, because the bids are due to be opened on January 5th; but it is to be hoped that shipowners will take full advantage of the opportunity and at least put in bids for purely nominal amounts—unless they have been enabled to get their approximate costs figured—and then complete the financial arrangements with the Board at a little later date. We believe the Board will be willing to follow the plan discussed in our last issue or some very similar arrangement, and we anticipate that arrangements will be made by Congress to finance shipowners through the Board in accordance with the proposal on the editorial page of this current number. Upon the success of this first offering no doubt depends the conversion of several hundred additional steam-ships.

Incidently, we would like to know exactly what is meant by the term "full Diesel" stipulated by the Board. We presume that "Diesel type" is really meant, and that it is intended to convey that engines of the surface-ignition, compound. Still and other wide variations shall not be included, but that it does not mean to exclude Diesel-type engines of the solid injection class. An engine is either a Diesel-engine or it is not a Diesel-engine, hence the terms "full-Diesel" and semi-Diesel" virtually mean nothing, and for a government to officially use them may cause a legal tangle. There are, as engineers know, several recognized variations of the Diesel principle which comes within the "Diesel-type" limits.

To almost split hairs, the fundamental features of the true Diesel principle is a heavy-oil or coal-dust burning internal-combustion engine having the following characteristics:—

(1) Compression of pure atmosphere to a degree that the temperature produced is adequate to the inflammation and combustion of the fuel.

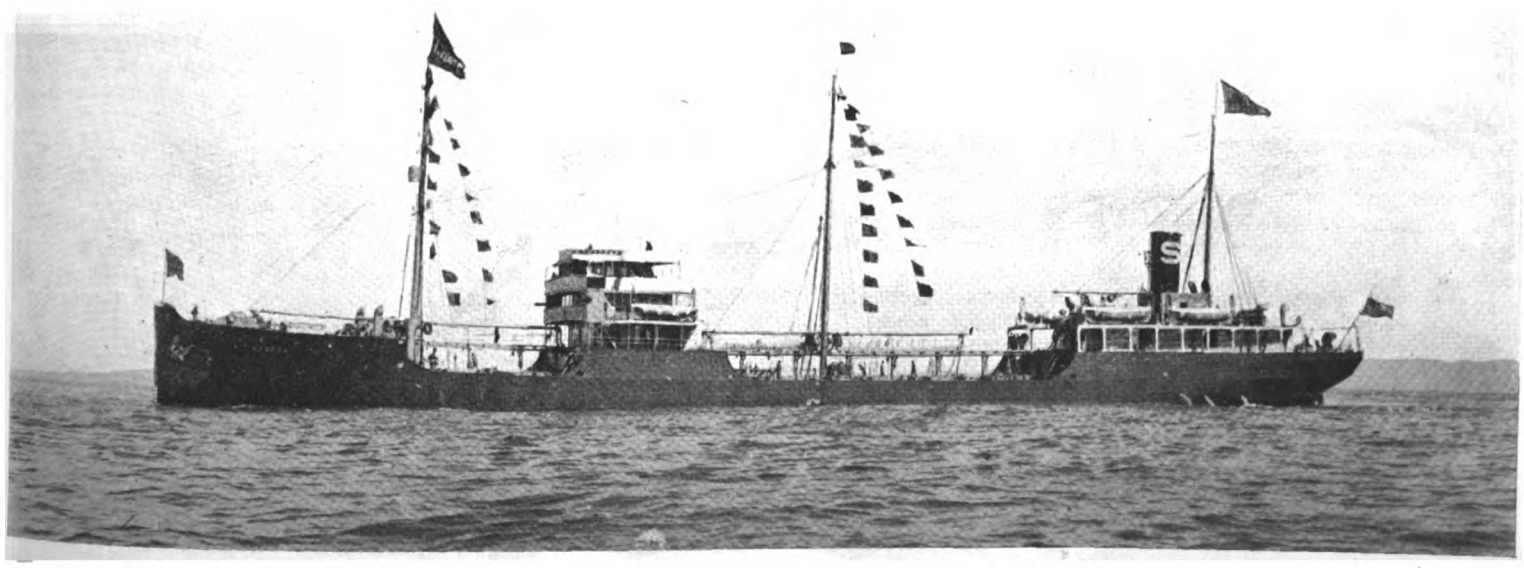
(2) Injection of fuel at such a rate that the burning proceeds without rise of pressure on combustion space. (This condition is not realized with absolute precision, there always being a slight rise of pressure when the fuel begins to burn.)

(3) The injection of fuel by air-blast that produces turbulence needed for good combustion. (This is essential but not distinctive or exclusive to the true Diesel cycle.)

The true Diesel cycle as now world-widely used is not according to the master patents taken-out in 1892 before Dr. Diesel made his conclusive patents, but according to the second engine built in 1896.

WHAT THE SHIPPING BOARD'S ADVERTISEMENT SAYS!

"PURCHASERS of these vessels will be required to replace the present machinery installation with full Diesel Propelling Power Plant, plans for which must be approved by the Emergency Fleet Corporation. A guarantee will be required at the time of sale. Prices will be considered on basis of hull value."



Broadside view of the Standard Oil Company's (Cal.) new Pacific-Werkspoor Diesel-engined tanker motorship "H. T. HARPER"

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Five Months in the Engine-Room of a Big Motorship

Interesting Experiences of a Swedish Civil-Engineer on a Voyage to the Far East—Details of Routine Adjustments and Repairs, with Suggestions for their Elimination

By HUGO MOREN

EARLY in the morning of the 9th of May—at 3:30, to be exact—our ship was passing through the Chajos Archipeligo off Six Islands with a smooth sea and a fine wind aft, when a heavy rain-squall came on. The look-out man could neither hear nor see anything within fifty yards. In the engine-room 15 minutes later (the watch was relieved at 4 o'clock) I signalled to my assistant at the refrigerating-machine, and attended some minor things which precede the relieving of the watch, and I took my position at the writing-desk beneath the engine telegraphs. The time was about 3:47 P. M.

Feeling that something was wrong with the engines, I looked at the tachometers and was alarmed to see them registering 80 r.p.m. instead of 102, as some minutes before. "What's the matter? Is the fuel-oil clogging again?" was my first thought, and some seconds later the floor commenced to shake, and the telegraphs from the bridge gave reversing orders, but too late; the ship was already ashore, touching very gently. The engines were stopped and reversed by me and my assistant in shortest possible time, and were running astern for about one hour.

The heavy rain-squall continued to about 4:15 P. M., and when it ceased we could perceive a fine green island straight before us. At the critical moment our navigating-officers had thought the ship was past Six Islands, and had omitted to warn us in the engine-room of that narrow and dangerous passage. They did not even slow down the engines during the squalls.

The tide was then running in, and near high tide at that. The cooling pipes burst at 3 o'clock because the tide was in again, and some wheat had been thrown overboard while both engines were again running astern. A bearing ran hot, so the starboard engine was stopped, but the port engine continued running solely. After a slight warning the ship jumped so violently on the coral rocks that all cooling-water pipes burst and the main engines were turned towards each other. The engineer-on-watch then rushed upon deck. Having explained what happened to the ship I will proceed to give some information regarding the operation of the machinery up to that time.

MAIN ENGINES

Fuel-Valves.—Some of the valve spindles became bent and consequently affected the packing. This bending, I believe, was due to the system of manufacturing and we found it very difficult and almost impossible to make them absolutely straight. During case-hardening the very hot spindles are dropped into the water or oil-bath and bend at that time. Then they are straightened and ground to sizes. To prevent trouble from bent valve-spindles it is imperative to choose material and system of hardening whereby the spindles will not bend during the process. Should any spindle become bent during the hardening process it should be rejected.

Krupp packing for fuel-valves is very soft, but all-right for ordinary good fuel-oil and straight spindles. In fact, in a wharf at Williamstown near Melbourne, Australia, I saw a packing material consisting of soft white-metal in use on a pair of Polar Diesel-engines delivered seven years ago from Stockholm. It is interesting to note that both the fuel-valves and fuel-pump plungers had been running between four and five years on heavy Borneo oil, yet the same packings were still in first-class condition. Mr. Chamberlain, the engineer-in-charge, gave me a sample of the packing material.

Exhaust-Valves.—Owing to a high percentage of sulphur and asphalt content in the fuel-oil we found it necessary to frequently change the exhaust-valves. But, on the return voyage we mixed some new fuel-oil taken on board at Suez, together with Borneo oil; nevertheless, we had to change exhaust-valves after twelve days' running. We could not get an entirely clear exhaust when running at 104 R. P. M. also the engine slowed down to between 80 and 90 R. P. M. owing to the asphaltic contents. This mixture was 25% Borneo and the balance Suez fuel-oil.

Regardless of the question of fuel-oil I believe it would be advisable to use monel-metal or similar material for the exhaust valve seats or a stainless steel would be adaptable, similar to metal used in some German airplane engines. The water-cooled gray-iron valve should have as long a life as any valve that seats a special metal. We found the temperature of the gases in the exhaust-pipes near the valves to vary between 380 and 400 degrees Cent. This high temperature represents a high thermal loss that should be taken care of as far as possible with future designs.

The seats of the starting-valves were rapidly burned, but durability could be gained by using a similar metal to that advocated for the exhaust-valve seats. Also, serious burning could be avoided by putting a thermometer or pet-cock in the airpipe. This remark also refers to the starting slide which is often locked when a starting-valve has a leak. On the return voyage five days before the vessel ran ashore we had rather a surprising experience with a starting valve that had become full of hard burnt scale from salt-water leaking from a crack in the cylinder-cover. Naturally, it is difficult to remove such a valve when locked in such a manner. All the pulling power from the strap and hook must pass through the spindle.

As there are only two starting-valves in reserve, it is necessary to avoid the risk of pulling-off the valve spindle. I propose a sleeve with its valve seat threaded at the top for the lifting tool. This was the result when we found that the traverse block was not sufficiently powerful to pull-off the starting spindle.

Compressor-Valves.—We had no trouble with the compressor-valves, they of course not being influenced by the fuel-oil, but some of the valve-covers were broken—owing to structural weaknesses, the dimensions being too weak in places. It is interesting to record that the operation of the main compressors was so excellent that we passed thro' the Suez Canal without maintaining the auxiliary compressor in operation.

Lubricating System.—In the tropical zone the temperature of the lubricating-oil rose to 52 degrees Cent. Consequently, in order to keep-up the oil-pressure the pump was forced to run at full-speed. Because the temperature of the cooling-water was not higher than 32 degrees C. an oil-cooler should be installed in all ships passing thro' the tropics, in order to reduce the temperature of the lubricating-oil to 40 degrees C. This arrangement worked satisfactorily on our ship. For lubrication of the thrust-bearing and propeller-shaft bearing, a simple wick device is adopted, but this needs frequent inspections. So, a self-contained oil cooler system should be installed at moderate cost, which would reduce the work of the engine-room crew. Thro' the lack of a De Laval oil-separator and an oil-press for cotton waste, a certain loss of lubricating-oil could not be avoided.

On the outward voyage the total lubricating-oil consumption was about 3½ tons. The daily consumption for the cylinders and compressors was about 25 liters, while the shaft-boxes took 7 liters.

Cooling System.—With this type of Diesel-engine the salt-water used for cooling the main-engine cylinders must not be too hot or scaling takes place, should a cover be cracked. In order to keep the temperature of the water at the outlet to below 45 degrees C. in the tropics, a cooling-water pump must be set to work at its full capacity and, consequently should be larger than the size at present installed. For the piston cooling telescopic-pipes are used with leather packings, but did not operate very long before they had to be renewed. A design which eliminates loose packings and obviates water being splashed-up to the cylinders should greatly improve the operation and design of the main engines.

We found that some of the piston-rings occasionally became locked in their grooves, so in my opinion it would be an advantage to keep the temperature of the cooling of the outlets well below 40 degrees C., but the outlet pipes are rather small for the large quantity of water needed to do this. The funnels thro' which the water passes are placed too high to be looked into, altho' the engineer could always watch for steam which issues as a warning when the temperature is too high.

Cylinder Covers.—In the heavy weather which we encountered between Sidney and Melbourne, a serious leak developed from one of the covers, necessitating our cutting-off the injection of fuel and the blast-air. Some more leaks developed with other covers later, but these were not sufficiently serious to cut them out. The leak was at the joint between the cylinder and cylinder head, the graphite paste on the metal joint being coarse and thick. A copper gasket might eliminate such a leak. [*Editors Note*: No packing is necessary at all. Metal to metal will suffice.]

AUXILIARY ENGINES

Valves.—As with the main engines, a little trouble resulted from the fuel-valve packing, a leakage soon resulting. The exhaust-valves had been running from 10 to 40 days on Borneo oil. At two different times one spindle was checked

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in its sleeve and became bent thro' hammering of the piston. At first we did not quite understand the cause of this, but discovered it thro' a curious experiment with one of the cams. The latter was grooved as if by heavy blows of the cam-roller and after we had smoothed out the grooves they reappeared slowly following a changing of the valves. We found that one of the inlet-valves touched the piston lightly when it was in its highest position, and a hammering resulted.

Pistons.—It will be observed that these engines run at high speed, with the result that hot lubricating-oil forced itself through all openings, regardless of packings, with the result that the engine is very dirty when running. To stop the lubricating-oil being forced-up into the cylinders an extension of gray-iron or aluminum alloy is secured to the piston by means of four screws. Several times this gray-iron extension worked loose and was smashed in the crank-chamber, but no other harm developed in this connection.

Compressor.—Lubricating-oil is pumped into the low compression compartment in spite of baffle-plates, owing to the design of these compressors being open into the crank-case. This low compression compartment is not water-cooled so is usually very hot and sometimes so hot that the oil is carbonized, resulting in clogging of the discharge and blow-off valves. This means frequent stops and cleanings. Therefore, I propose a remedy, namely, water-cooling the low pressure chamber and fitting of an oil-draining valve.

Regarding the high-pressure chamber it was sometimes difficult to secure a tight fit for the valves in the cylinder casing. A broken valve-spring has been quite common, so in order to prevent repetition, I would recommend fitting two small springs. Air is sucked in all the time by the compressor at full capacity and compressed into the low-pressure receiver. Then it is partly blown-off thro' the end regulated relief-valve in order to keep the blast-air pressure constant. Because the lubricating-oil is pumped into the cylinder, I believe it would be better to regulate the induction-air and thereby avoid high temperatures and lost energy. When at sea the auxiliary engine receives its blast-air from the main compressor and can be loaded 25 per cent higher.

Incidently, I will mention that when we ran ashore the auxiliary engine No. 3 was going, and was receiving its blast-air from the port main engine. I immediately got order to reverse and endeavored to carry-out the order, but nothing happend. Had the main engines only been stopped the auxiliary engine would have soon run-out of blast-air and perhaps exploded, as no one gave a thought to it under the unusual circumstances.

Had not some of the cooling-water pipes broken through deformations in the bottom of the hull, we would have now been afloat by unloading the ship. But, as it was we could not even prevent her from being swung round by the strong current on to shore wards, and being carried higher on the coral reefs by the heavy seas.

Air-Circulating System.—The question of good air ventilation in the engine-room of a motorship is a very important factor, especially in tropical zones, where temperatures as high as 45 degrees Cent. have been recorded with some motorships, or 10 to 15 degrees Cent. higher than on deck. Cool fresh-air should be fed by fans to the inlet-valves of both compressors and Diesel-engines, while at the skylights slow-running fans should be installed, one being of 5 ft. at the forward end delivering fresh air into the engine-room, with the other at the after end forcing-out the hot air.

Bilge Pumps.—In my opinion these are rather small and their valves need careful driving to avoid damaging by too heavy blows, on its seats. The bronze springs often became broken and had to be replaced by steel springs. Together with the bilge-water a certain amount of lubricating and fuel-oil was lost in the sea, so a good separator would soon pay its initial cost.

Refrigerating-Machinery.—In this vessel the ice plant was placed in the fore-part of the engine-room over the daily fuel-tanks, with the result that a man had to be specially stationed there the entire time it was in operation. But, if the refrigerator was placed between the engines or between the thrust-bearings it could be attended to by the engineer on watch or by one of his assistants. Drinking-water could easily be cooled by a shunt pipe.

Regarding the little electric-motor operating the lathe in the workshop, its shaft became broken while the ship was at sea. Consequently, we had to borrow an electric-motor from the sausage-grinder in the steward's compartment in order to drive the lathe while turning a new shaft. Instead of having one motor-driving the various tools in the workshop, there should be a separate motor for each tool.

Shortly after the vessel ran ashore all iron piping between the cooling-water pumps and the bulkhead walls was broken by deformation in the hull, but we connected a hose from the deck water-fittings to one of the auxiliary Diesel-engines and ran it in order to generate electric-light, power for the refrigerating machinery, and the wireless. For such occasions it is well to have reserve gasolene or surface-ignition oil-engines, particularly to generate current. As there was no reserve plant a little spare steam-compressor was fitted-up as a steam power-plant using a compressed-air bottle as a boiler. While we could not send messages any great distance, our radio operator could hear Colombo.

Shortly after we commenced our home journey we went on board another Diesel motorship owned by the same company. Her engines were using a better grade of oil than we had on our boat, but nevertheless, they had to make the following stops on her long trip east.

1. Twice changing fuel-valves, 15 min. and 30 min. respectively.
2. Twice changing exhaust-valves, 1 hr. and 4 hrs. respectively.
3. Twice changing starting-valves 40 mins. and 1½ hrs. respectively.
4. Tightening piston-rods on starboard engines 2½ hrs.

After these unusual experiences with the four-stroke type Diesel engine I will be interested to know how two-cycle engines operate on long voyages, and trust that some engineer with such experience will send them to "Motorship" for publication.—H. M.

Compounding the Combustion Engine

Paper Read at the Annual Meeting of the American Society of Mechanical Engineers, New York, Dec. 5-9, 1921.

By ELMER A. SPERRY.

THE author of this paper has ever been foremost among engineers in developing new types of engineering devices, and in considering a paper by Elmer A. Sperry, one expects to find exploitation of engineering principles which are not only unusual in common practice, but which indicate thorough and painstaking investigation and actual construction of many experimental engines.

In Mr. Sperry's paper the history of the theory of compounding combustion-engines is briefly reviewed and one may be rather surprised to learn that a group of engineers headed by Mr. Sperry has been experimenting with and developing compound internal-combustion-engines since 1890, the first patents being dated December 10, 1892. A great many engines have been built, tested, modifid and more than a thousand indicator cards have been taken and studied. The outcome has justified the theories as Mr. Sperry has recently built compound-oil-engines on order and engineers who have witnessed tests have been pleased.

In his paper Mr. Sperry mentions the reliability and economy of the large Diesel-engine as being firmly established, but as objectionable features names the greater weight and higher first-cost of the Diesel-engine as compared with steam-installations. He also deals with the requirement of the usual Diesel-installation of using Diesel-oil fuel whereas the steam-plant uses boiler-oil. While this is undoubtedly now true, steps are being taken whereby the usual Diesel-engine will regularly operate on boiler-oil, and Mr. Sperry's own compound-engine will use this fuel.

The weight and consequent high cost of Diesel-engines is due, according to this paper, to the presence of very high pressures, being designed around an extremely small quantity of air and oxygen at each stroke, surprisingly minute when compared with the size of the engine. In the indicator-card of the Diesel-engine it will be seen that the expansion-pressures occurring after the peak of compression is reached should do their work in a high-pressure cylinder and the lower pressures of the curve where the expansion-pressures drop off and exhaust takes place should take place in a low-pressure cylinder suitable for the purpose. To so distribute these pressures so that this arrangement is obtained is the principle of the compound combustion-engine.

Compressing in two stages gives a much larger unit volume of gases, clearance spaces many times those of the Diesel are possible and yet it is possible to bring these larger volumes up to requisite pressure and incandescent temperatures at the instant of fuel-injection. The larger volume of gases in the combustion-chamber of the compound-engine overcome the necessity for large chilled walls, the chilled perimeter per unit volume of gas not being the controlling factor as in the Diesel, chilled walls for high and low-pressure cylinders being reduced 60% over the usual Diesel-type.

With large clearance volume difficulty with solid-injection is minimized and very heavy fuels may be more efficiently used as experiemnts have proved that efficiency drops when the oil-spray encounters chilled or even red-hot walls. In the compound-engine the clearance volume is so large that the entire high-pressure piston displacement causes it to lose only a fraction of its pressure, thus bringing to the low-pressure cylinder both ample volume and pressure so that this piston is driven to the end of its stroke with pressures still above the atmosphere. In this way the engine yields an expansion ratio based on gage pressures, which instead of being 3 or 4 to 1, as in the automobile engine, or about 12 to 1 in the Diesel, can be made as high as 120 to 1.

The first-stage compression enters the cylinder on its "out" stroke with the pressure about 113 lbs. The induction-valve closes and on the "in" stroke the compression proper starts and rises to Diesel values; there being no fuel-injection the receding stroke brings the pressures down on practically the same line to the point where the transfer-valve opens and the gases pass on the "in" stroke to the low-pressure cylinder. On the "out" stroke of the low-pressure the pressures sink to a trifle below atmosphere before the final exhaust-valve opens and continues open nearly during the entire next stroke of the low-pressure piston.

Rather than working toward the elimination of "detonation" of the fuel in the engine Mr. Sperry advocates utilizing detonation pressures, as experiments by Eng-Comdr. Hawkes, proved that thermodynamic efficiency was higher in case of high detonation. Complete suppression of pre-ignition is one of the features of the compound-engine. In the four-cycle Diesel-engine high pressures persist only about 2½ per cent of the time; over 95 per cent of the time either low-pressures or no pressures at all are present, whereas in the compound the pressures persist clear across the card, and we are dealing with blocks of power.

Instead of 60-70 lbs. net mean effective to the crank, delivering its power through a few degrees only of one stroke in four, in the compound we have two net mean effectives, each of 300-400 lbs. per sq. in., succeding each other and covering two strokes out of the four from a single fuel-injection. This gives much better crank-effort distribution for power purposes. Two large blocks of power are secured not by any material increase of pressures, but by large quantities of power gases and "hanging on" to the pressures throughout practically two complete strokes, clear across the card twice, thus abstracting much more of the power they contain before exhausing.

Thus a light-speed compound-engine weighing as low as one-twentieth that of the slow-speed Diesel-engine in some cases, and commonly 30 lbs. per B.H.P., is produced which Mr. Sperry claims will do the same work as the crosshead Diesel-engine weighing 450 lbs. per B.H.P., and occupying more than twice the space. Used in conjunction with the Sperry magnetic-clutch, Mr. Sperry feels that such an installation would be about ideal.

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Performance of an American Diesel-driven Ship

Motorship "Kennecott" Has Run 40,000 Miles Using Boiler-Oil.—Unloads Full Cargo in Three Days

HARDLY had our December number—in which the use of boiler-oil was advocated for motorship use—come from the press, when the 6,010 tons deadweight motorship "Kennecott" arrived at New York from the West coast. She was referred to in our editorial on page 979 of the December issue as one of the vessels which used boiler-oil, the same heavy-oil that is used in oil-burning boilers of steamship installations.

The "Kennecott" left San Pedro, Calif., Nov. 17th, and arrived at New York at 1 p.m. on Friday, Dec. 9th, with a full cargo and deck load of lumber. It certainly speaks, volumes both for the Williams Steamship Co. who are operating the vessel and for the economy, efficiency and reputation of the "Kennecott" that she comes into port loaded to capacity during a period when a thousand American steamers are tied-up. Her cargo on this trip consisted of 50,000 cases of canned goods, about 2,000 tons of miscellaneous cargo such as bagged beans, Australian brown onions, floor (which we understand is a new product to be shipped by sea from the West to the East coast) heavy machinery for export, doors, raisins, etc. and about 650,000 ft. of lumber on deck. Her stay in port was very short considering the large cargo she had to un-load, this being effected by her Cunningham electric-winches in exactly 3 days, including time necessary to shift from New York dock to dock in Brooklyn. She sailed at 1 P. M. on Monday, the 12th, for Philadelphia to load.

But, it is chiefly because of the use of heavy fuel-oil by her McIntosh and Seymour Diesel-engines that a representative of "Motorship" again went aboard soon after the "Kennecott" arrived at New York. Chief-Engineer Searles reported a very satisfactory trip, the engines operating with perfect reliability continuously. While Californian oil of 16.7 degrees Baumé is ordinarily used 14 degrees Beaumé oil having about 3 per cent sulphur was taken on and used, generally in the warmer sections of the voyage where the amount of heating necessary is lesser. Both the double-bottom and the daily-service tanks are provided with hot-water heating-coils, the water being heated by coils surrounding the exhaust-silencers of the main engines.

The engines are started on oil of about 18 degrees Baumé, and when the oil in the daily-service tanks has been heated to about 150 degrees Fahr. so as to flow readily the 14 degrees oil is substituted and the heat is then shot through the double-bottom. In the event of no lighter oil than the latter being available for starting, there are electric-heaters fitted to heat this heavy-oil to the proper fluid state.

The whole engineer-force is composed of competent and experienced Americans who take great pride in their work and in the condition of the machinery as well as the whole engine-room. One complete set of exhaust-valves is always kept in reserve, and at the end of the coast-to-coast voyage some of the valves are renewed from the spare set and then the used set is reground and ready for the next change. The exhaust-valves are the only parts at all affected by the use of this boiler-oil high in sulphur content, and it is hoped that with the more extensive use of special composition for valves that this trouble will cease. The engineers on the "Kennecott" have been shipmates with both steam and Diesel-engines and are unanimous in saying that they would rather run a Diesel-engine on boiler-oil than run an oil-burning steam-plant. They prefer the boiler-oil to the Diesel-oil, so we were told by the company's superintending-engineer.

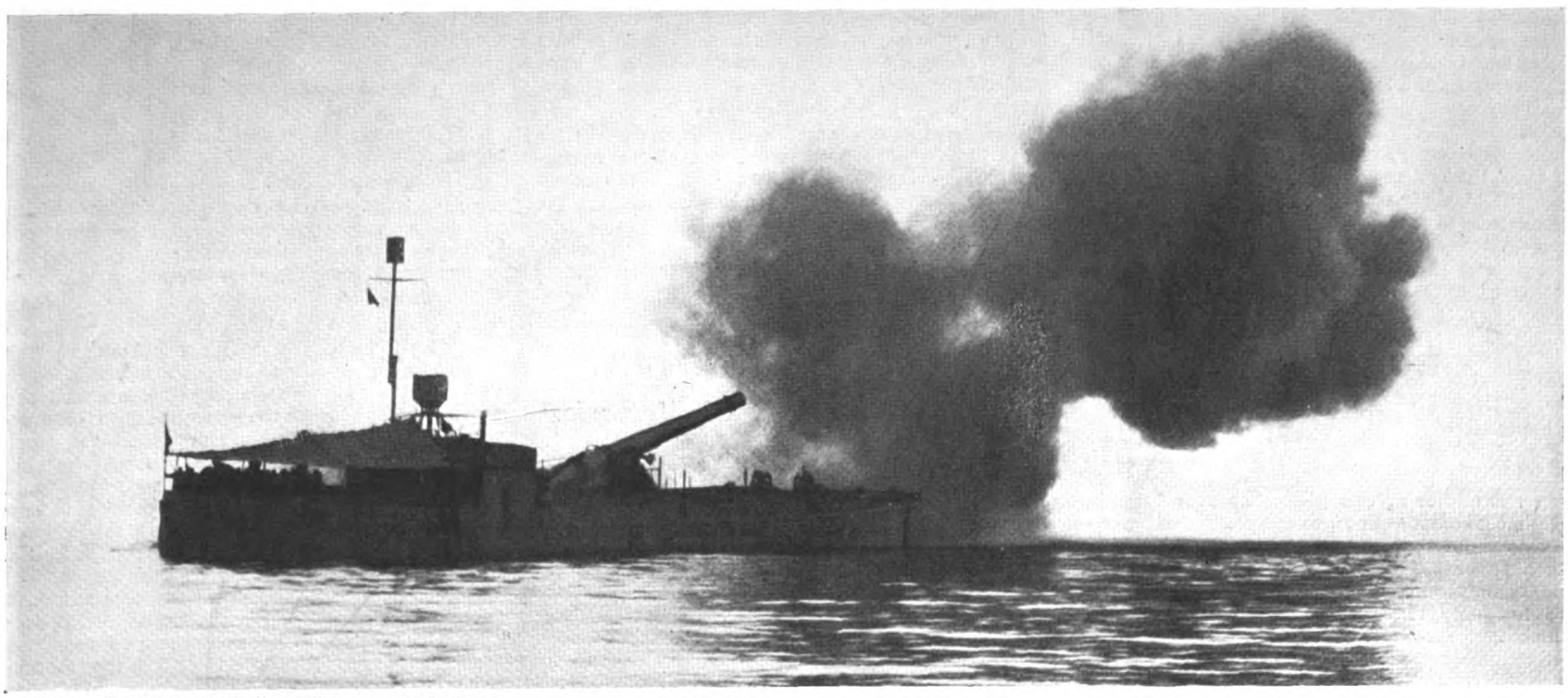

Photo. Courtesy of Italian Ministry of Marine.
"Grappa," one of four Diesel-driven Italian war ships armed with a 15 in. gun (40 calb.). She is propelled by twin 350 b.h.p. Ansaldo-San Giorgio two-cycle Diesel-engines

MOTORSHIP "TISNAREN" AT NEW ORLEANS

The Swedish motorship "Tisnaren" of the Transatlantic Company cleared from New Orleans early in December with a cargo of 19,000 bales of cotton and 4,250 tons of phosphate for Far Eastern and Japanese points. She was in command of Captain B. Lilliestierna, with A. Svensson as chief-engineer. The captain told our representative an interesting story of his numerous voyages around the world and stated that it was the "Tisnaren's" first trip to the United States.

On this last trip she left Gothenburg, Sweden, October 22 and reached Savannah after thirteen days of the roughest weather ever experienced. She then came to New Orleans via Tampa. The captain explained that she maintained an average speed of about fifteen knots with favorable weather conditions, and that on his previous trip from Hamburg to Brisbane, Australia, the ship made fourteen knots, a journey of more than 13,000 miles through the Panama Canal. [This speed seems a little high, as the sister motorships average about 12½ knots.—*Editor.*]

The "Tisnaren's" daily fuel-consumption has been 14 tons, Captain Lilliestierna said, and she carries a supply sufficient to last 110 cruising days. He explained that the fuel he took on at New Orleans was the first since last March, notwithstanding his long voyages.

As readers of "Motorship" are aware, this vessel is driven by two 6-cylinder Diesel oil engines of 2,000 i.h.p. each, or a total of 4,000 i.h.p. She has twin-screws and of 9,400 net tonnage. In addition to this cargo capacity she is equipped to carry 12 first-class passengers. She was built and engined by the Götaverken, Göteborg, Sweden, and has been in successful operation three years.

INTEREST IN MOTORSHIPS

At the Marine Show, in talking with representatives of manufacturers, many of whom make nothing that can be used on a motorship, our representative found that "Motorship" was being read and looked to as THE authority on this type of vessel, and what it can do to help America out of its present shipping difficulties. Many manufacturers who have until now catered only to steamship requirements advised us that they were carefully studying the motorship field to determine what their plants could manufacture along those lines, for with so many steamships idle and such little hope of new steamers being built they felt that they must either manufacture motorship equipment or get out of marine business.

THE INTEREST IN MOTORSHIPS IN GREAT BRITAIN

Looking through a recent issue of a well-known British shipbuilding paper devoted principally to steamship construction we were enabled to secure a conception of the present interest in motorships in that country. We noticed that ten leading shipbuilders were advertising Diesel engines and motorships in a total of ten advertising pages. Also there were a number of shipbuilders who are actually building motorships and Diesel engines that made no mention of the same in their publicity. In addition, there were four foreign firms advertising—using 3½ pages space.

ALLENS TO BUILD BURMEISTER & WAIN ENGINES—NOT TOSI

Following information received from what should have been a reliable source, we stated in our November issue that W. H. Allen Sons & Co., Ltd., Bedford, England, had secured a Tosi Diesel license. However, we have been informed by Messrs. Allen that this is incorrect, but that they have acquired a license from Harland & Wolff to construct Burmeister & Wain Diesel engines for ship's engine-room auxiliary purposes. We gladly give publicity to these facts.

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More on the Motorship "Havelland"

Views of an American Engineer Who Visited this Interesting Reduction-Gear Driven Vessel

(Following the visit of our representative on board the Hamburg-American Line's new motorship "HAVELLAND" we requested an American Engineer experienced in Diesel Engine design—who had the opportunity of visiting the ship—to favor our readers with his views on the installation.—*Editor.*)

As this noteworthy German ship was described and illustrated in the Nov. issue of "Motorship," there is no need of a re-description at this time, except to say that on the voyage over the two Diesel-engines together averaged 3,603 indicated h.p. at about 230 r.p.m., the ship at times attaining a speed of 14 knots maximum, or an average of 11-12 knots for the trip of 5,200 nautical-miles.

Under way pretty rough weather was encountered, and the propellers were out of the water most of the time; but I am told the engines did not over-speed much, due to the quick cutting-in of a centrifugal-governor. It will be recalled that the ship is 450 ft. long, 58 ft. wide, and has a displacement of 14,700 tons loaded and 4,600 tons light, or 10,235 tons d.w.c.

The reduction-gears work entirely under oil-pressure in an enclosed casing. This oil-pressure is given from an overhead tank located at about 35 ft. above the reduction-gear. Between the reduction-gear and propeller is located a one-collar thrust-bearing of the Michell type. Reduction-gear and thrust-bearing worked without any trouble during the whole trip. Much attention was given to the make of these gears and special machines were purchased by Blohm & Voss for cutting them. The teeth are cut close to 1/1000 m.m. The gears are enclosed in a cast-iron housing; the lower part of the housing forming the bedplate being very substantial and avoids any bending. The main engines have a piston-velocity of 800 ft. per minute. The mean effective-pressure is therefore 79 pounds per square inch, and the mechanical-efficiency 78.5 per cent. The firing orders of the ten four cycle type cylinders are—for the starboard engine:

1, 7, 3, 9, 5, 10, 4, 8, 2, 6.

For the port engine:

1, 6, 2, 8, 4, 10, 5, 9, 3, 7.

For manoeuvring purposes there are two auxiliary units, which are M.A.N. 4-cycle Diesel-engines of 180 b.h.p. each when running at 300 r.p.m. Piston diameter 13.8 in., stroke 15.8 in. This speed can be reduced to 200 r.p.m. by a hand device attached to the governor. These auxiliary engines are connected to 95 kw., D.C. generators and an auxiliary air-compressor, furnishing air for manoeuvring purposes. The generators are located between compressor and engine, and the compressors are coupled to the generator-shafts through clutches, being drawn in or out by hand. When the air-compressor is running absorbing about 120 b.h.p. the output of the generator is only a fractional one.

In addition to these two auxiliary engines, they have one 15 h.p. surface-ignition oil-engine connected to a 10 kw., D. C. generator for lighting purposes. An emergency compressor is installed and driven by a 5 h.p. surface-ignition oil-engine. All of the auxiliary machinery, as well as winches and capstans, is driven electrically. There are 13 electric-winches on deck, of which nine are of 3 tons and four are of 5 tons.

The steering-gear is also actuated by electric motor, and represents the newest construction with regard to safety and simplicity. No steam is used on the entire ship for operating or heating purposes, but the builders have installed one small boiler in accordance with the Lloyds rule for fire purposes. Cooking is done on board with coal. Heating of the accommodations is effected by hot-air, which is heated by the exhaust-gases of the engine.

The engines are started and manoeuvred with compressed-air of 400 to 450 pounds per square inch. The air-pressure coming from the starting-bottles is reduced through an air-reduction valve. A safety-valve is located in the starting-air line which is set at 700 lbs. pressure. Safety-valves are also provided for the different stages of the compressor. They are set as follows:

For the first stage—7 to 8 pounds.
Second stage—18 to 150 pounds.
Third stage—850 pounds.
Fourth stage—1,150 pounds.

Air for fuel-injection purposes is kept in a special bottle at 1,000 to 1,100 pounds. Before starting the engine this bottle is opened and the air-pressure is automatically reduced by a reduction-valve, to about 600 pounds for the lowest speed. This reduction-valve regulates the air-pressure according to the engine-speed, and the operating-engineer has nothing to do whatever with the injection-pressure.

Only one kind of lubricating-oil is used throughout the whole installation. It is a mineral-base oil. The cooling-water for the engines is furnished by centrifugal pumps and enters the engines under a pressure of 10 to 15 pounds. It is sea-water. Exhaust-valve cages and exhaust-valves are water-cooled separately. The outlet temperatures of oil and water are indicated by thermometers. The water outlets are in groups for each cylinder, while the oil outlets are grouped in one for each engine. Oil cooling for the pistons is at 42 to 50 lbs. pressure.

Manoeuvring is effected with two levers and one hand-wheel. The hand-wheel operates a servo-motor actuating the lever shaft, and moves the cam-shaft longitudinally 2 in. When the cam-shaft is set and the valve-levers lowered, the engine can be started. This starting is effected by the two levers mentioned above, each lever commanding five cylinders. To start the engine only one lever has to be operated and only five cylinders will receive air. The engine speeds-up and the other five cylinders can be set on oil directly. In case the first cylinders should not fire immediately or accelerate the engine enough, the other group of five cylinders can be put on air. When the engine has a speed of between 50 and 100, one group of cylinders can be drawn from air to fuel and the other group can follow immediately.

Motorship "HAVELLAND" entering New Orleans harbor

Manoeuvring takes place in about 6 to 8 seconds. The fuel-oil is regulated by a second hand-wheel, which operates directly the suction-valves of the fuel-pumps. The fuel-oil used on these engines is Pennsylvania oil of about 34 degrees Baumé, containing no asphaltum and very little sulphur. The flame point of the oil is 203 degrees F. The initial cylinder compression-pressure is 480 pounds per square inch. The exhaust is absolutely clear. No lower grade of fuel-oil is recommended to be used on these high-speed submarine engines. The fuel-oil consumption is an average of 0.33 pound per i.h.p. hour.

The exhaust-valves of all cylinders were removed while in New Orleans, and only a little dirt had accumulated on them during the trip. All valves have been re-ground. The fuel-injection valves, two in number per cylinder, are driven by one rocker-lever of such a design that the stroke on both valves is the same.

The piping both for air-suction and exhaust is arranged to serve the cylinders in pairs. This is done by the alternate arrangement of exhaust and inlet valves. All piping is very neatly bent and so located that no piping is in the way of the operating engineer.

All water-pipes are made of copper, while for low-pressure air steel pipes are used. For high-pressure air, copper pipes are used.

The volumetric clearance for the compressor pistons are as follows:

First stage.....1.5 to 1.8 m.m.
Second stage.....1.2 to 1.5 m.m.
Third and fourth stages..0.75 to 1.0 m.m.

For each engine is provided a compressed-air storage in four seamless drawn steel bottles. The air pressure in these bottles is kept at 1,000 to 1,200 pounds. The diameter of these bottles is approximately 20 in. and about 10 to 12 ft. long.

The "Havelland" has accomodation for twelve cabin passengers. The crew of the whole ship is 50 men. The engine-room crew consists of 19 men, chief-engineer included. The sister ship under construction at the Blohm & Voss works, of the same size and the same engines, will have accommodation for 25 cabin passengers. A third motorship of the same capacity is under construction, but will be fitted with two slow-speed heavy-duty Diesel engines running at 95 r.p.m., of 1,750 b.h.p. each and drawings were given in "Motorship" last month. This is the M.S. "'Westerland."

From an engineering standpoint the "Havelland" represents a thoroughly studied installation, with the exception of few auxiliary pumps, of which design the writer is not in favor. The main and auxiliary Diesel-engines, as well as the reduction-gears, are designed with a complete comprehension of the work they have to perform. Nothing has been omitted, making the main-engines with the necessary care given a successful propelling-unit. Reduction-gears and thrust-blocks are working very satisfactorily, but require the operating engineers' constant eye.

Personally, the writer is not in favor of high-speed Diesel-engines, neither for stationary or marine purposes; and I would never design or advise the design of a marine-engine without cross-head. I must state that the main engines in the "Havelland" are very complicated, and the accessibility of the moving parts is reduced to its minimum. In making the statement of its complication, I have in mind the 80 valves with necessary mechanism with which the main engines are fitted, as well as to the reversing-mechanism, safety and interlocking devices.

Such an engine can only be handled by highly-skilled operating engineers, having a thorough knowledge of Diesel engines, and I hardly believe such engines would be an advisable proposition for conversion of American steamships as we lack highly-trained operating engineers which are absolutely necessary for success. In this case, of course, the submarine engines were available, and so were made use of to propel this ship.

European designers are fully aware of the fact that a submarine type Diesel-engine is not the coming propelling-engine for freighters, and the time is not far off when heavy-duty marine Diesel-engines with lower speeds than now used will be marketed.

OPERATES MOTORSHIP EXCLUSIVELY.

Now that they have sold seven steamers to Hugo Stinnes, the Johnson North Star Line's fleet consists entirely of motorships, of which fact champions of this type of vessel—says "Syren & Shipping" have every right to make the most.

MOTORSHIPS THROUGH PANAMA CANAL

We note from the Panama Canal Record that for one recent month out of 236 ships passing through the Canal 12 were motorships. Not such a large percentage, you say, but we find that during this period only minor repairs are reported on one auxiliary motor-schooner, whereas repairs to 13 steamships are reported by the Panama repair-shop.

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Design of Air Compressors for Marine Diesel Engines

A Valuable Technical Treatise of Particular Interest to Engine Designers and Builders

By DAVID BRUCE

AT the present moment when the airless, or mechanical injection engine is coming into prominence, and claiming among other advantages the elimination of the air system, it is a fitting time to look into the design of the compressor, as a great many of the troubles in these machines have been due solely to faulty design, and are not natural defects of air-compressing machinery. This article therefore, while not entering into any argument as to the respective merits of the two systems, which the author has done previously in this magazine, will deal with the practical side of compressor design as applied to marine oil-engines.

Air may be compressed or expanded, by either of two distinct methods; or by a combination of the two; thus it may be accomplished isothermally, where the temperature is kept constant, or adiabatically where there is no heat added or taken from the air during the operation. In adiabatic expansion it follows that the temperature of the air falls, and that it rises during compression, while it further follows that heat must be added to the air during isothermal expansion in order to keep the temperature constant, and heat taken away during compression.

Now it can be proved that the work done varies with the method of compressing, thus less work is required when it is done isothermally than when it is done adiabatically. This can be more readily seen when referring to Fig 1, in which pressures and volumes are plotted together the area under the curve thus being an index of the work required. The isothermal curve is obtained by the formula PV^n is a Constant, where "n" is equal to 1, while for adiabatic the value of "n" is 1.41.

In practice the compressor cylinder is fitted with a water-jacket

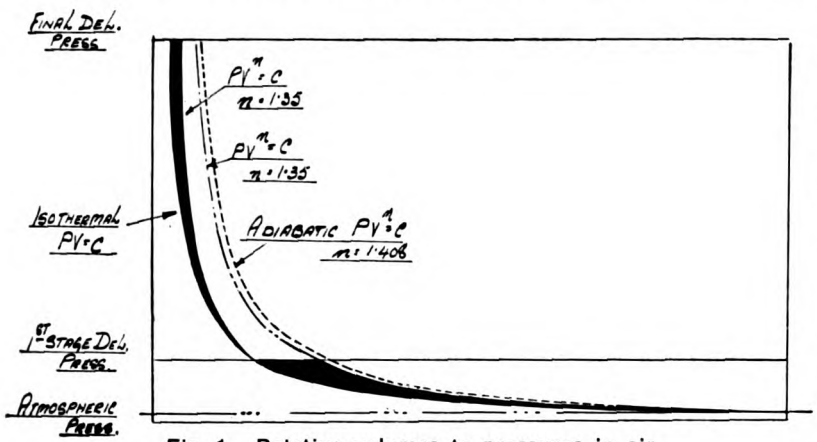


Fig. 1. Relative volumes to pressures in air-compressor cylinder

for removing the heat, but it is impossible to provide a jacket which will remove all the heat as it is generated, thus the curve in Fig. 1 must lie between the two already shown, with a value of "n" between 1 and 1.41, the actual value being 1.35. This curve is shown in the illustration. All the curves dealt with so far are assuming single stage machines, i.e., that the whole operation is carried out in one cylinder without interruption, this is alright for low pressures, but where high pressures have to be considered it is obvious that the temperature would also be very high, such temperatures soon growing beyond the limits of practical workmanship.

For this reason, and also for a certain saving in work which will be considered later, stage compression is resorted to; in other words the air is compressed in one cylinder up to a predetermined pressure in the usual way, and discharged to an air cooler where the remaining heat is removed, by this means the volume is reduced to that which would be attained by isothermal compression. The air then passes to the next cylinder where the operation is repeated until the desired final pressure is reached. Referring again to the diagram the blackened portions indicate the increased work required for stage compression over isothermal, but the saving over adiabatic will also be noticed. It is not possible to lay down rules for fixing the pressure requiring any special number of stages, but the following figures may be taken as a guide:

Single-stage—100 lbs. per sq. inch.
Two-stage—600 lbs. per sq. inch.
Three-stage—1,500 lbs. per sq. inch.
Four-stage—3,000 lbs. per sq. inch.

It will be seen from the list that for Diesel work three stages should be employed, although for auxiliary machines two stages are at times used. Table 1 shows the work required to compress one lb. of free air per min. to a given pressure, from this table the power necessary to drive the machine, and also the saving effected by stage compression can be obtained. Thus to compress 300 cu. ft. of free air to a pressure of 1,000 lbs. sq. inch in two stages would require 108.6 H. P., while with three stages 97.8 H. P. only is required, thus there is a saving of 108 H. P. Where the size of the compressor warrants it four-stage compression may be adopted; but it is doubtful whether the extra expense is justified as against the adoption of twin machinery.

COMPRESSOR CAPACITY

The capacity of a compressor is generally given in cubic feet of free air per minute. This value being equal to the volume of the first stage cylinder, multiplied by the number of revs. per minute, and is thus the volume of air drawn into the machine, the volume actually delivered is of course very much smaller. In commencing to design a compressor it is necessary to know the volume of free air required, in a marine Diesel engine this must be large enough to keep all the fuel-valves supplied, with a reserve capacity for recharging the manoeuvring air receivers. This latter duty is of course very intermittent, and it follows that the compressor must be capable of working at either of two capacities as required, the smaller capacity being the one in general use.

In a marine Diesel-engine the first stage-cylinder-volume is made a percentage of the total volume of the working-cylinders, it being impossible to give any definite method of calculating the same. The percentage varies from 8-10% as experience decides, this value does not require any adjustment for the clearance, providing of course that this be kept as small as possible. Practically all marine Diesel-engine compressors are as explained before of the three-stage type, but as there are often cases where two-stage machines are employed as auxiliaries, both types will be deal with here. Now for each stage to do its even proportion of work, each one should pass the air through the same compression ratio, and therefor the delivery pressure of each stage should follow some definite law of progression.

Table 2 gives the figures for two- and three-stage machines, while Table 3 gives the actual terminal figures in each stage as resolved for final delivery pressures of 1,015 and 1,215 lbs. per sq. inch abs., and also for initial pressures of 12 and 14.7 lbs. per sq. inch abs. Either of the two lower pressures may occur according to actual running conditions, for instance if the compressor under consideration is more generally working at full capacity, as is the case in small auxiliary machines, or the manoeuvring air-compressor on a mechanical-injection engine, the initial pressure will be practically atmospheric, i.e. 14.7 lbs. sq. inch, providing of course that the general design of suction-valves, etc., is correct; but on the main-engine compressor which is only occasionally running at full load, the initial pressure falls below atmospheric due to wire drawing through the partially closed throttle. It is obvious that throttling must be provided in order to obtain the reduced capacity. Fig. 2 shows an actual first-stage indicator-card, which clearly shows the drop in pressure below the atmospheric line.

The diameter of each stage cylinder for two- and three-stage machines is given in Table 4, the diameters given therein are of course reckoning on independent cylinders being employed for each

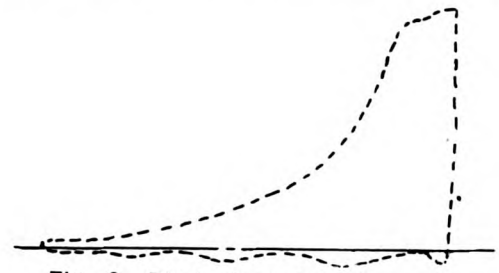


Fig. 2. First stage indicator card

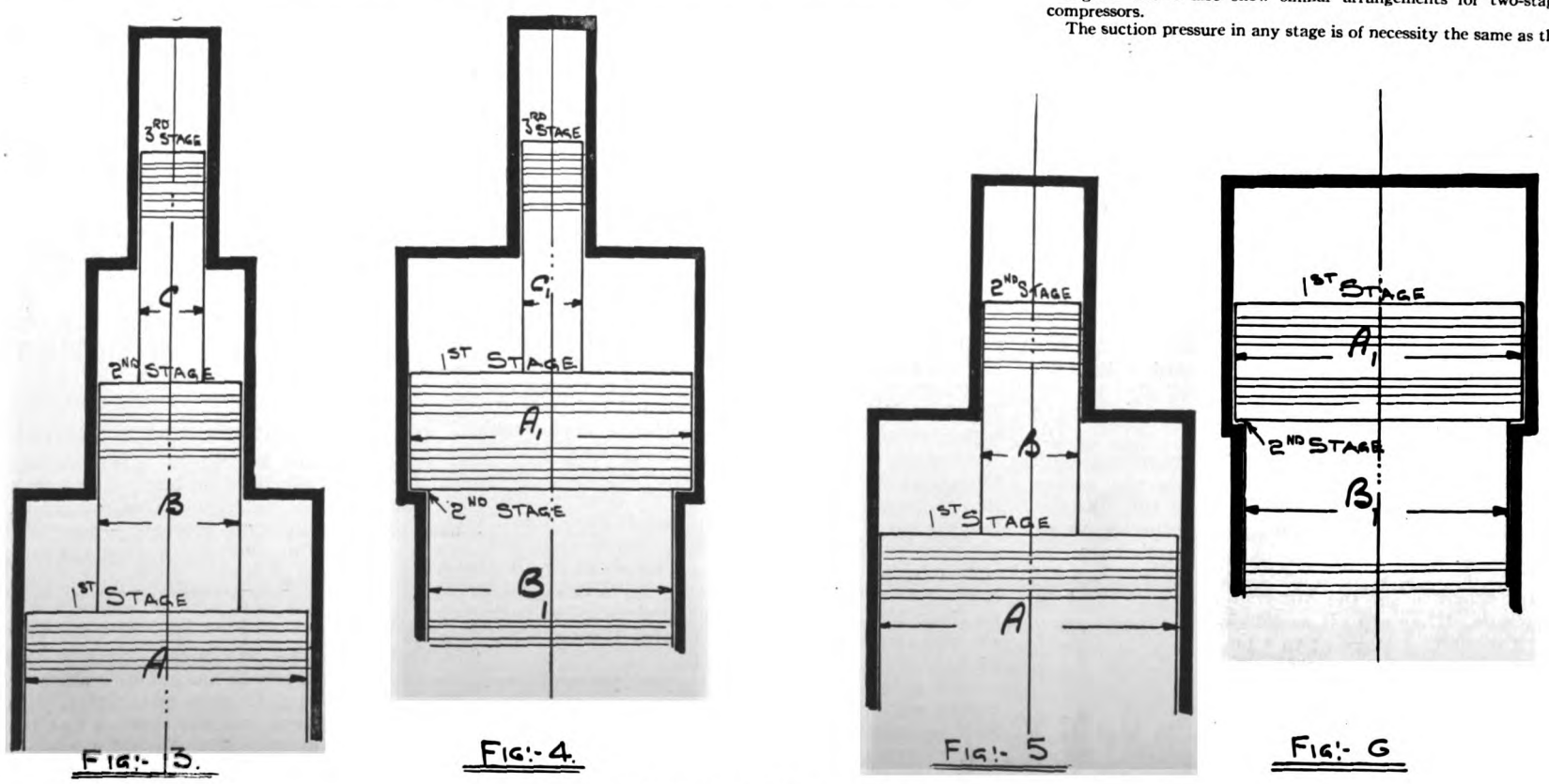
stage; but in practice this is very rarely the case as a great saving of weight, space, and power can be effected by adopting a combination of pistons and cylinders. There are numerous combinations possible: Fig. 3 shows diagramatically what is probably the most simple combination in use, where the three stages are superimposed one upon the other, the three pistons being in common.

The first and second stages are formed by the lower and middle steps respectively, the third stage being formed by the small top piston, as indicated in the sketch. Now although this is a simple type, and has other advantages which will be dealt with later, it has a very serious drawback in that when the crank is on its inner centre the pressure in each stage is at its maximum, and the total downward load on the working parts is equal to the sum of the total loads on each stage, the total load on any one stage being equal to the area of that stage piston multiplied by the delivery pressure. In this type of machine the downward load is of greater consequence in that the load is always downward, and is not reversed, thus rendering the lubrication of the various parts concerned much more difficult, as the continual downward pressure on the bearing ruins the oil film so necessary for efficient lubrication.

Fig. 4 shows an alternative method of combining the stages which while reducing the maximum downward load, also brings into play an upward load, which in turn has a lifting effect on the working parts and so helps the lubrication of the same. It will be seen from the sketch that the second stage is formed by the annular space below the first stage portion of the piston. The third stage being formed as before by a separate small piston.

Figs. 5 and 6 also show similar arrangements for two-stage compressors.

The suction pressure in any stage is of necessity the same as the



Types of compressor stage combinations

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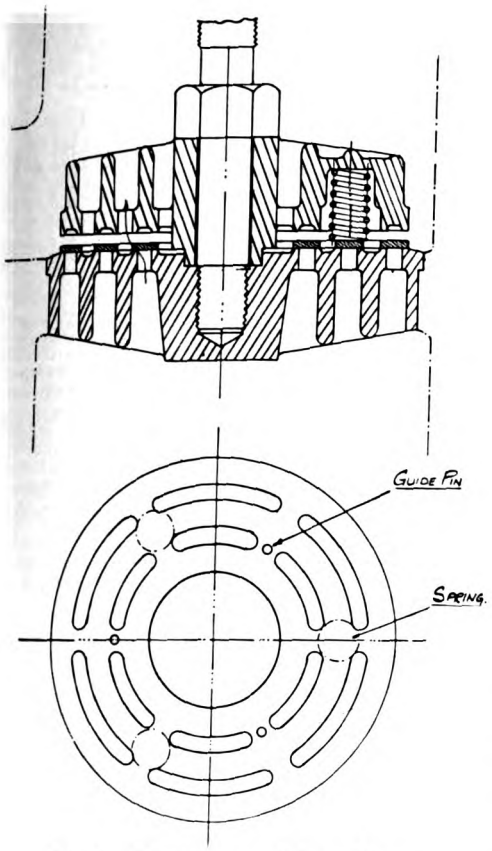

Fig. 8. Compressor plate valves

delivery pressure of the preceding stage, so it follows that in a two-stage compressor of this type there is a net downward load equal to the difference in the area of the two stages, multiplied by the 1st stage delivery pressure. The net upward load at the bottom centre is equal to the 2nd-stage area, multiplied by the final pressure minus the initial suction pressure, as the downward load in this case is partially balanced by the open portion of the piston. These loads should be obtained for every compressor, as they must be carried by the connecting rod and crankshaft bearings, and when calculating them an allowance should be made for the momentary rise in pressure due to the valves lagging slightly at the point of opening, this being unavoidable in automatic valves.

In three-stage compressors where the diameter of the first-stage cylinder is coming out very large, it is sometimes divided, and an arrangement such as shown in Fig. 7 adopted, where the second stage is superimposed on one first stage and the third is superimposed on the other. Of course this has the previous objection that all the loads act downwards at the same time, and therefore a better way is to make two small compressors of the type shown in Fig. 4.

Now it is obvious that the cylinder diameters as found by Table 4 will not hold good for any of the cylinder combinations given, but that the areas given by these diameters would have to be similarly combined, and the equivalent diameter found from the new area. For instance consider a three-stage machine with pistons superimposed as in Fig. 3, here the third-stage diameter will be as given in the table, but the second-stage diameter must be such that its area will be equal to the sum of the actual areas of the second and third stages as found from the table.

Similarly the first-stage diameter must be such that its area will be equal to the sum of the actual areas of all the stages. To simplify the work of getting-out these sizes therefore, Table 5 has been prepared which gives the corrected value of the respective diameters for all the types shown in the preceding figures. In this table it should be remembered that the value of D is that obtained by taking the percentage of the working cylinder volumes as previously described. The table it should be further noticed has been calculated for initial pressures of 12, and 14.7 lbs. sq. inch, and for final pressures of 1,015 and 1,215 lbs. sq. inch respectively as in the previous cases.

The next point to consider is the type of valve to be used for the suction and discharge. These valves are in every case automatic and must be so placed that the minimun extra clearance only is allowed in the cylinder, and they must also be large enough to allow of a maximum air speed through them of 120–130 feet per second. To keep within this speed limit in a large cylinder would require a very large valve, so large in fact as to at once prohibit fitting the same, consequently in the larger stages, two or three similar valves are fitted.

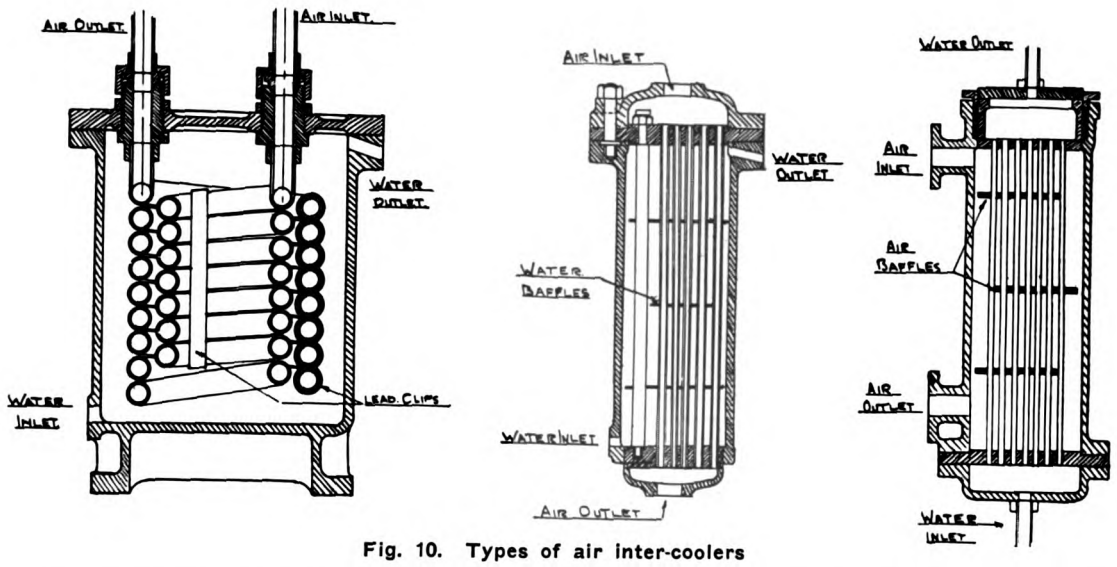

Fig. 10. Types of air inter-coolers

In some high pressure stages where the diameter of the cylinder is very small it is sometimes advisable to fit small thimble and poppet valves. Fig. 8 illustrates the design and method of housing the plate valve referred to. It will be seen that the plate is provided with a number of circular ports, making it in effect a number of light rings joined at various points to provide the necessary stiffness these rings seat on very narrow faces on the housing, and as the area through the valve is equal to the total circumference of the ports, multiplied by the lift of the plate, it follows that very large areas are obtained for very small lifts of the valve. This type of valve then is ideal for compressor work, as it embodies all that is so necessary in air-compressor valves. The cage above the plate is provided with a number of small springs of moderately light load, while a number of small pegs or guide-pins keep the plate located on the faces

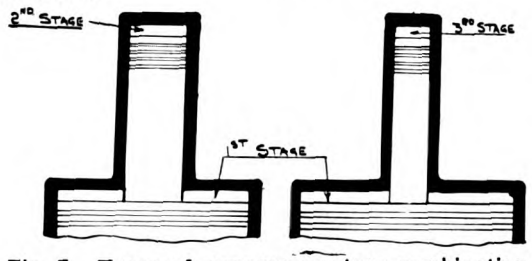

Fig. 7. Types of compressor stage combination

The casing has also a number of passages cast in it to allow the air a free outlet on the discharge side, and an inlet free from wire drawing on the suction side. For calculating the dimensions of the springs the following figures may be taken as a basis, the figures giving the total spring load on the valve which should be divided between the number of springs necessary to give an even distribution of the load over the whole valve.

SPRING LOADS ON COMPRESSOR VALVES

1st Stage—1 lb. per sq. inch.
2nd Stage—1 lb. per sq. inch.
3rd Stage—Suct. 5, Dis. 40 lbs. per sq. inch.

When obtaining the speed of the air through the valve it is as well to check the area through the passages in the housing, and through the cage, as occasionally these may be found to be smaller than the area through the valve plate.

Fig. 9 shows the inlet and outlet valves as adopted on small high-pressure stages, the inlet being a mushroom and the outlet a thimble valve, the reason for fitting this type of valve in this case is that for small areas the plate-valve is apt to take up too much room, and in the small diameter available it is impossible to fit them. In this case the spring load as given above is carried by one spring only. The area through these valves is obtained in the usual way by taking the inner circumference of the valve seat, and multiplying by the lift of the valve.

Having taken the design so far, it is now possible to make the preliminary arrangement of the compressor which is so necessary for the best grouping of the coolers, separators, etc., which have to be fitted, and also for arranging the best run of the pipes: from this arrangement also the various parts may be schemed out with a view to their relative position, and the necessary clearances. In arranging the coolers, etc., these should be situated in such a manner as to allow the discharge pipes from the various cylinders to be as long as possible, thus giving them a certain extra cooling possibility from the atmosphere which would not otherwise be obtained.

There are several types of air coolers in use, the three more general types being indicated in Fig. 10. The first type consists of a coiled tube immersed in a cast box through which the cooling medium is claculated, the air passing through the tube. The coil is held by the connections at the two ends of the coil, and is also clipped in three places by strips of lead to prevent any vibration in the coil which would tend to start cracks.

The second type consists of a nest of straight tubes held between two tube plates, the air again passing through the tubes and the water circulating round the outside, to obtain the full cooling service from the water, baffle plates are fitted to restrain the flow. The tubes are of small bore, and thereby may be of small gauge. The plates are held at the necessary spacing by two or more stays, and the tubes are expanded into the plates, being relieved of all load by the stays mentioned.

The third type is very similar to the last one described, but having the air passing round the tubes, and the water through them, but the practice is not to be recommended, the former being the more efficient. Cooling surface is obtained by taking the inner circumference of the tubes, and multiplying by the length between the tube plates, and by the number of tubes employed. It is this figure that forms the basis for designing the cooler for although it is not possible to give any definite governing data for determining the amount of cooling surface to be allowed it is only a matter of basing them upon some nominal value, usually obtained from experience. The following figures are of such a nature, and should therefore be taken as minimum figures only.

1st Stage—1 sq. ft. of cooling surface per 20 cu. ft. of cyl. volume.
2nd Stage—1 sq. ft. of cooling surface per 10 cu. ft. of cyl. volume.
3rd Stage—1 sq. ft. of cooling surface per 4 cu. ft. of cyl. volume.

Returning to the details of the coolers, the coil-type calls for no special remarks, but it is necessary in the tube bundle types to allow for the expansion of the tubes due to the high temperatures encountered, thus the upper tube-plate is held to the cooler-body by the studs securing the cover, while the lower one held only by the stays mentioned previously is free to move through the neck of the casing as required. This is only possible in the type where the water passes through the body, and the air through the tubes, as it is necessary to provide a free joint between the lower plate and the body, which would not be possible were the high air-pressure to be reckoned with, as it is however, two grooves are provided around the tube plate into which are sprung two rubber rings, these pressing against the body create the joint. The same effect may be obtained by fitting a gland around the lower tube plate,

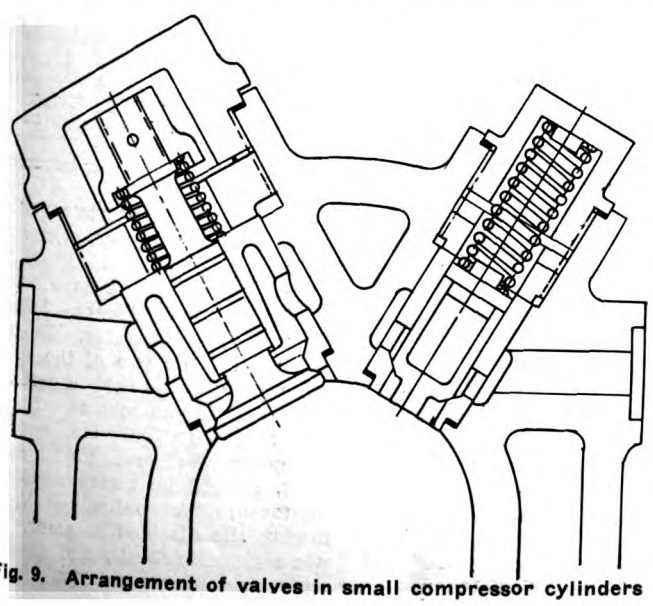

Fig. 9. Arrangement of valves in small compressor cylinders

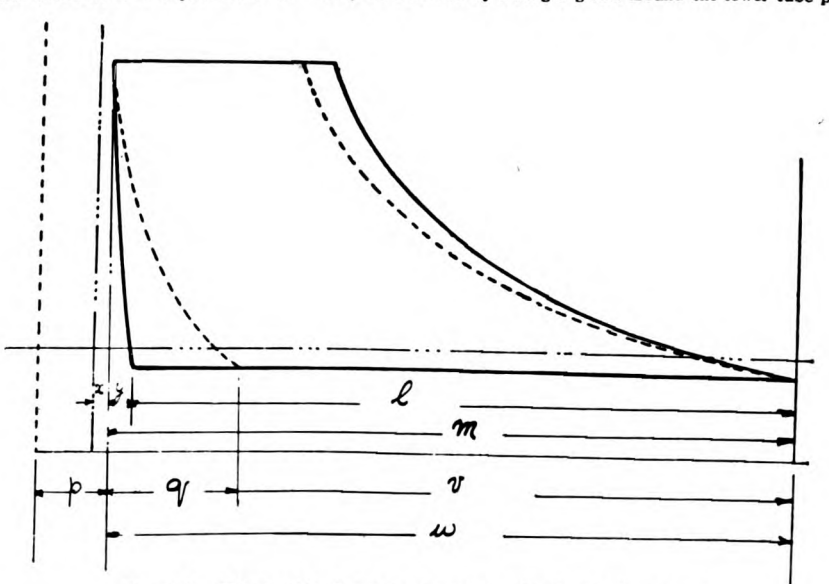

Fig. 11. Theoretical card showing effect of clearance

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but this is needless expense, the rubber rings being quite efficient.

Where the air travels through the tubes, there is the danger on the higher stages that should any of the tubes fail the high pressure air would leak into the body, and this not being designed to withstand such high pressures would burst with perhaps dangerous consequences; to prevent this then the practice is adopted of fitting a rubber diaphragm-plate to the side of the cooler body, the thickness being such that on the pressure rising very much above the normal the diaphragm would burst and so relieve the dangerous pressure.

There is always the possibility of moisture collecting in the air in its passage through the cylinder and coolers, and it is advisable to remove this between each stage, and to do this separators are fitted below each intercooler; these are of simple design as a general rule, although fancy designs are sometimes fitted when considered necessary. The usual design consists of a cylindrical body formed generally of steel tube, fitted to special head pieces, an inner tube leads about three parts of the way down the centre of the body. The action of the separator is as follows, the air enters by the central tube at fairly high velocity, and on reaching the bottom of the tube has to turn quickly, and return up between the two tubes, in effecting the reversal of direction any moisture in the air is thrown to the bottom of the separator, from where it may be periodically drained.

At a very slight extra expense the separator may be greatly improved by fitting a cast headpiece having a spiral passage cast for a little distance within it, the air entering by way of the spiral passage has a rotary motion imparted to it, thus causing a certain amount of the floating moisture to be thrown on to the sides of the separator, to then drain to the bottom, meanwhile the same effect as before is obtained on the reversal of the air stream, in this case the outlet being up the tube.

Before closing this paper, a word or two as to clearance volumes will be of advantage, thus assume a compressor cylinder delivering at a pressure of 80 lbs. per sq. inch, the suction-pressure being atmospheric, and the valves automatic as described. It being impossible to avoid having a certain amount of clearance volume, it follows that this volume will at the end of the compression stroke be full of air at 80 lbs. pressure, and as the suction-valve will only open on the pressure in the cylinder falling to that of the atmosphere, it further follows that the suction valve will not open until the piston has travelled far enough to allow the clearance air to expand to atmospheric pressure. The portion of the stroke required to do this being useless, the efficiency of the machine therefore depends on the percentage clearance volume; in other words the volumetric efficiency of a compressor is equal to the amount of air drawn into the machine in relation to the stroke volume of the machine.

This can be illustrated better on the indicator card than in any other way. Fig. 2 shows two theoretical indicator-cards, the one shown in full has a clearance volume of 2% as represented by "x" on the diagram requiring to be re-expanded to the point "y" in order to enable the suction-valve to open at the suction-pressure of 12 lbs. in this case. On the same diagram the dotted card has a clearance volume of 10% as indicated by "p" requiring to be re-expanded to the point "q" in order to allow the suction valve to open. The volumetric efficiency is shown by the value of l/m, and v/w for the 2, and the 10% respectively.

In the cards shown these values are 96.4% and 88% respectively. This clearly shows the necessity of keeping the clearance volume as low as can be arranged in accordance with working conditions, although in some of the small marine compressors as manufactured by independent makers the practice of omitting certain valves, say the second-stage delivery valves, and allowing the next stage suction valves only to provide the separation between the two stages, it will now be recognized that this means a big drop in the efficiency of the compressor. Of course where the above practice is resorted to, the lower stage is of course delivering while the succeeding one is on its suction stroke, so that on the higher stage delivery-stroke, the pressure in the cylinder keeps the valve tight.

With regard to drawing the theoretical indicator-card for any stage of the compressor, the first-stage should first be set down, and to do this the assumed suction pressure-line is set down to a convenient scale. This may be either 12 or 14.7 lbs. as mentioned previously. The length of the stroke and the clearance-volume lines are then set down as the vertical ordinates, now taking the total cylinder volume, i.e., including the clearance, the compression curve is calculated for various points, until the curve passes the designed terminal pressure for the first stage. The law for the curve is taken at—

P. V. n=C where "n" is 1.35.

This curve is plotted up to the terminal pressure line, which then lies horizontal to the end of the stroke. The re-expansion line is also calculated to the above value of "n", only the initial value of P is now the terminal pressure, and the initial volume is the clearance volume of the cylinder. The next stage card may be drawn independently and to the same scale if desired, or it may be drawn in conjunction with the present card by calculating the volume that would attain at the end of the first stage had the compression followed the law for isothermal compression, i.e., where—

P. V.=Constant.

This value marked along the terminal pressure line for the first stage would give the relative length of stroke to be allowed for the second stage, and similarly for each succeeding stage.

REVIEW

"Yacht Cruising" by Claud Worth, Second Edition, 438 Pages. Published by J. D. Potter, London. We have greatly enjoyed reading this book containing so much of interest to the cruising yachtsman. Much of the charm of this book is due to the long personal experience of the author being told in such fascinating manner, also awakening in the reader a desire to cruise. Mr. Worth, knowing the sea through many years of association and loving yachts as only a master sailor can, is exceptionally well qualified to help other yachtsmen through the pages devoted to sails, ballasting, seaworthiness, ground tackle, winches, provisioning, painting, dinghies, etc. This work is attractively printed and well illustrated.

CARGO OF MOTORSHIP "PACIFIC"

Recently the Johnson motor-liner "Pacific" arrived in San Francisco from Antwerp with 1500 tons of pig iron, 1,000 cases of glass, and 250 tons of wood pulp. She loaded with American products and sailed for Copenhagen.

NO MOTORSHIPS FOR PENINSULA LUMBER COMPANY

A report appeared in a British publication that the Peninsula Lumber Co. of Portland had decided to instal Diesel-engines in four Ferris type wooden hulls. However, we have been advised that there is no foundation to this report.

ABSENCE OF MOTORSHIP CASUALTIES

To those who follow the reports of marine casualties it is interesting to note that rarely is a break-down or accident reported to a motorship. Even considering the larger numbers of steamships operating, the record of modern motorships is nearly perfect. In the record we have before us are reported 33 accidents divided as follows 26 steamers, 6 schooners, 1 motorship. The motorship simply grounded while two of the steamers were towed to port and 1 was held in port unable to proceed because of engine repairs. The other casualties were from fire, collision, and going ashore. Often motorships have towed disabled steamers to port, as will be remembered in the case of the motorship "Australien" of the East Asiatic Co. towing the disabled steamer "Lowncore" which she sighted in the Gulf of Aden more than a year ago.

TABLES ACCOMPANYING MR. BRUCE'S ARTICLE ON AIR-COMPRESSORS

TABLE 1.—H. P. to compress one cu. ft. of air per minute to given gauge pressure

Press. lbs. sq. inch	n. 1.35 One	Two	Three	Four	n. 1.3 One	Two	Three	Four	n. 1.25 One	Two	Three	Four
100	17	15	144	14	168	149	142	14	163	146	134	13
150	215	184	173	167	207	178	170	166	197	173	166	163
200	249	205	194	188	238	201	191	186	227	197	188	187
250	277	224	21	207	263	221	207	202	251	215	205	199
300	300	241	224	219	285	235	222	215	271	229	218	212
350	322	254	237	230	305	249	233	226	289	243	231	223
400	342	268	248	240	322	261	243	236	306	254	240	233
450	358	279	257	248	339	272	254	245	319	263	249	242
500	374	289	266	256	353	283	262	253	332	274	257	249
550	388	298	274	264	366	291	270	260	345	282	265	256
600	404	307	282	271	379	299	277	267	356	290	272	263
650	417	315	288	278	391	307	285	273	367	298	279	270
700	428	323	295	284	402	315	291	279	376	305	285	276
750	442	330	301	289	413	321	296	284	385	312	290	281
800	452	336	307	294	423	327	302	290	394	318	295	286
850	464	343	312	299	433	334	307	295	402	324	300	290
900	474	350	316	304	442	339	312	299	410	329	305	294
950	484	356	321	308	451	345	316	303	418	334	309	298
1,000	495	362	326	312	459	350	321	308	426	339	313	302
1,050	500	367	331	316	468	355	326	311	434	343	317	307
1,100	514	372	336	320	476	369	329	315	441	347	321	311
1,150	523	377	340	324	283	365	334	319	448	351	326	314
1,200	532	382	344	328	491	369	337	322	454	355	330	317

TABLE 2.—Intermediate Pressures

P Initial Press. Abs.

No. of Stages	1st Stage	2nd Stage	(a) Ratio of Compression 3rd Stage	4th Stage
2	P (a) ½	P (a)	....	....
3	P (a)	P (a)	P (a)	....
4	P (a) ¼	P (a) ½	P (a) ¾	P (a)

TABLE 3.—Actual Intermediate Pressures. Two and three stages

No. of Stages	Initial Press.	1st Stage	2nd Stage	3rd Stage
2	12	120	1215	....
	12	110.4	1015	....
	14.7	133.7	1215	....
	14.7	122.2	1015	....
3	12	55.8	254.7	1215
	12	52.7	231.3	1015
	14.7	63.7	277.7	1215
	14.7	60.3	247.5	1015

NOTE—All pressures are absolute.

TABLE 4.—Cylinder diameters for various pressures

No. of Stages	Initial Press.	Final Press.	1st Stage	2nd Stage	3rd Stage	4th Stage
2	12	1215	D.	.3152D	.....	.....
	12	1015	D.	.3298D	.....	.....
	14.7	1215	D.	.3316D	.....	.....
	14.7	1015	D.	.3469D	.....	.....
3	12	1215	D.	.4634D	.2147D	.....
	12	1015	D.	.4773D	.2278D	.....
	14.7	1215	D.	.4792D	.2296D	.....
	14.7	1015	D.	.4938D	.2438D	.....
4	12	1215	D.	.5615D	.3152D	.1771D
	12	1015	D.	.5742D	.3298D	.1893D
	14.7	1215	D.	.5759D	.3316D	.1909D
	14.7	1015	D.	.5589D	.3469D	.2043D

TABLE 5.—Actual cylinder diameters

TWO STAGE: FIGURES 5 AND 6

Initial Press.	Final Press.	A	B	A 1	B 1
12	1015	1.052D	.3298D	1.0D	.9436D
12	1215	1.048D	.3152D	1.0D	.952D
14.7	1015	1.060D	.3469D	1.0D	.9378D
14.7	1215	1.0515D	.3316D	1.0D	.9435D

THREE STAGE: FIGURES 3 AND 4.

Initial Press.	Final Press.	A	B	C	A 1	B 1	C 1
12	1015	1.13D	.529D	.2278D	1.026D	.909D	.2278D
12	1215	1.122D	.503D	.2147D	1.023D	.914D	.2147D
14.7	1015	1.145D	.552D	.2438D	1.029D	.904D	.2438D
14.7	1215	1.129D	.532D	.2296D	1.028D	.908D	2296D

THREE STAGE: FIGURE 7.

Initial Press.	Final Press.	A	B	C
12	1015	.7999D	.4773D	.2278D
12	1215	.7979D	.4634D	.2147D
14.7	1015	.8073D	.4938D	.2438D
14.7	1215	.8000D	.4792D	.2296D

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Motorships on the Great Lakes

At the present time there are no motorships in service on the Great Lakes other than the large sea-going barges of the Interwaterways Lines, which are operating through the New York State Canal carrying grain. Several motorships were placed on the Great Lakes in the early days of the Diesel-engine namely, the "Toiler," "Bacoi" ex "Calgary" and "Fordonian." Also, a Diesel-electric ship named "Tynemount" was built in England for the Lakes, but was not placed in service. The "Toiler" was underpowered and now has steam. The "Bacoi" also was underpowered and now has larger engines being in ocean service. Also the "Fordonian" was underpowered and now is having Diesel-electric drive installed for Atlantic Ocean service.

The first four vessels were not ideal in lay-out, resulting in considerable prejudice among Great Lakes shipowners with the consequence that no further motor vessels have been constructed. It is possible that this prejudice may be wiped-away by the pressure of the importance of economical operation. Once this does occur, there is but little doubt that a number of existing Great Lakes steamships will be converted to Diesel or Diesel-electric power.

Recently an investigation of the subject was made by Mr. Ian L. McKenzie, a naval-architect of Hamilton, Ont., and data for a canal-sized Great Lakes steamer was taken from a vessel already in service and the figures worked-out as closely as possible from available data of modern Diesel machinery. We attach the results of the investigations as follows:

Particulars of Ships

	Steamer	Motorship
Length (OA)	258′ 0″	258′ 0″
Length (BP)	250′ 0″	250′ 0″
Beam (MD)	42′ 6″	42′ 6″
Depth (MD)	24′ 0″	24′ 0″
Load draught	20′ 0″	20′ 0″
Block coefficient	0.82	0.82
Light displacement fresh water	1,406 tons	1,394 tons
Load displacement fresh water	4,840 tons	4,840 tons
Weight steel hull	1,050 tons	1,050 tons
Weight of machinery	282 tons	270 tons
Weight furnishings and crew	120 tons	120 tons
Deadweight capacity	3,388 tons	3,400 tons
Speed loaded	10¼ miles	10¼ miles
Cargo capacity grain in bulk	154,319 cu. ft.	167,759 cu. ft.
Cargo capacity iron ore	3,388 tons	3,400 tons
Cargo capacity bales per cu. ft.	149,298 cu. ft.	162,738 tons
Fuel (oil)		155 tons
Fuel (coal)	155 tons	.....
Daily fuel-consumption at sea	18 tons	4 tons
Daily fuel-consumption in port	6 tons	¼ ton
Indicated horse-power	919 H. P.	1,000 H.P.
Boilers	2 scotch 11′ 0″ x 13′ 0″ 180 lbs.	.....
Main engine	18-30½-52 x 33	Six cyl'dr four cycle. Diesel
Auxiliaries	Independent steam	Independent electric
Engine revolutions per minute	85	120

Comparison Data Based Upon the Steamships Now in Service

Propeller diameter	13′ 6″	11′ 3″
Propeller pitch	12′ 3″	11′ 0″

Wages

	Steamer per month	Motorship per month
Captain	$250.00	$250.00
1st officer	150.00	150.00
2nd officer	125.00	125.00
Wheelsmen (2 @ $85.00)	170.00	170.00
Watchmen (2 @ 85.00)	170.00	170.00
Deckhands (4 @ 60.00)	240.00	240.00
Firemen (4 @ 85.00)	340.00	.....
Oilers (2 @ 85.00)	170.00	170.00
Chief-engineer	225.00	225.00
2nd Engineer	150.00	150.00
Cook	110.00	110.00
Porter	60.00	60.00
Monthly pay roll	$2,160.00	$1,820.00
Months of operation	8	8
Total	$17,280.00	$14,560.00
No. in crew	21 men	17 men

Hours of Operation

Hours at sea	4,134	4,134
Hours in port	746	746
Hours in operation	4,880	4,880
Fuel burned at sea	3,100 tons	689 tons
Fuel burned in port	186 tons	24 tons
Total fuel burned	3,286 tons	713 tons
Cost of fuel per ton	$8	$20
Total cost of fuel	$26,288.00	$14,260.00

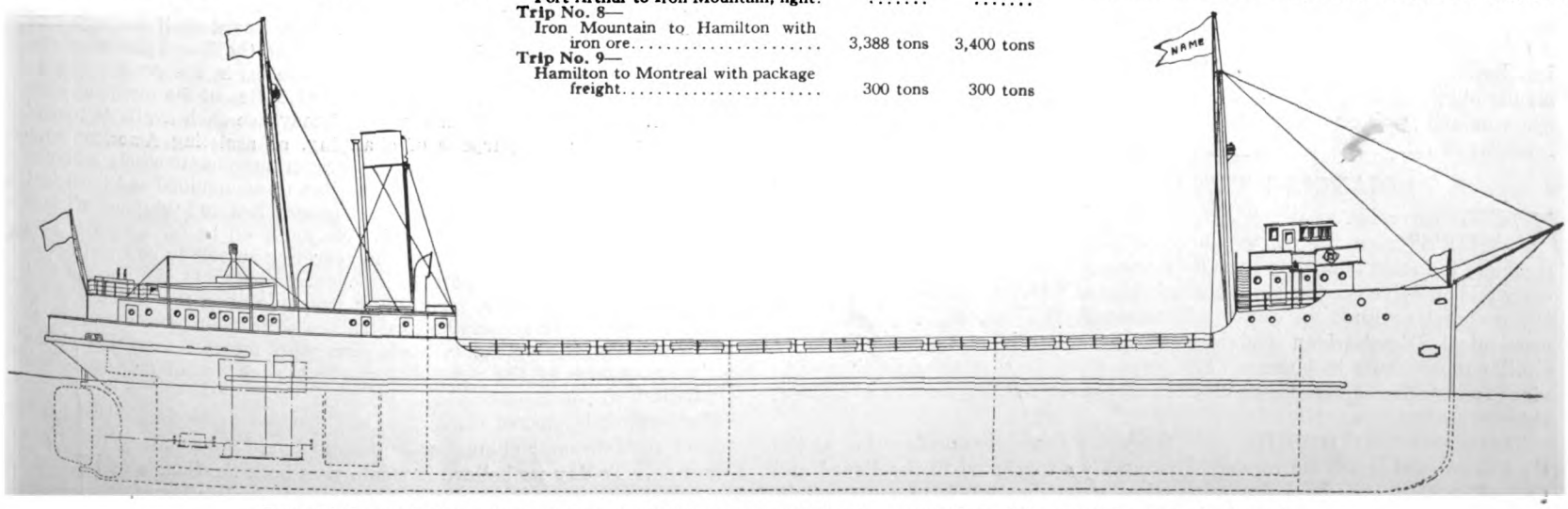
Cost of Operation for 8 Months

	Steamer	Motorship
Wages	$17,280.00	$14,560.00
Food	6,200.00	5,100.00
Engine-Room expenses	800.00	640.00
Fuel	26,288.00	14,260.00
Taxes	600.00	600.00
Depreciation	2,541.00	2,720.00
Insurance	4,000.00	4,000.00
Upkeep and repairs	5,000.00	5,000.00
Office expense	4,000.00	4,000.00
Loading and unloading	2,976.00	2,976.00
	$67,685.00	$53,856.00
Freight Revenue	$121,545.60	122,954.00
Disbursements	67,685.00	53,856.00
	$53,860.60	$69,098.00

In addition the motorship would still have sufficient fuel left in bunkers to permit of sale of fuel-oil at various points along the route, thereby increasing her total revenue above the figures shown.

Trip Record for the Season

	Steamer	Motorship
Trip No. 1— Hamilton to Toledo, light	.....	.....
Trip No. 2— Toledo to Port Arthur with coal	3,388 tons	3,400 tons
Trip No. 3— Port Arthur to Port Colborne with grain	126,480 bu.	126,928 bu.
Trip No. 4— Port Colborne to Montreal with grain	84,000 bu.	89,000 bu.
Trip No. 5— Montreal to Ashtabula, light	.....	.....
Trip No. 6— Ashtabula to Port Arthur with coal	3,388 tons	3,400 tons
Trip No. 7— Port Arthur to Iron Mountain, light	.....	.....
Trip No. 8— Iron Mountain to Hamilton with iron ore	3,388 tons	3,400 tons
Trip No. 9— Hamilton to Montreal with package freight	300 tons	300 tons
Trip No. 10— Montreal to Tadousac, light	.....	.....
Trip No. 11— Tadousac to Welland with pulpwood	1,200 tons	1,200 tons
Trip No. 12— Welland to Conneaut, light	.....	.....
Trip No. 13— Conneaut to Fort William with coal	3,388 tons	3,400 tons
Trip No. 14— Fort William to Duluth, light	.....	.....
Trip No. 15— Duluth to Point Edward with iron ore	3,388 tons	3,400 tons
Trip No. 16— Point Edward to Port Arthur, light	.....	.....
Trip No. 17— Port Arthur to Port Colborne with grain	126,480 bu.	126,928 bu.
Trip No. 18— Port Colborne to Sydney with grain	84,000 bu.	89,000 bu.
Trip No. 19— Sydney to Montreal with coal	3,388 tons	3,400 tons
Trip No. 20— Montreal to Hamilton with package freight	500 tons	500 tons
Trip No. 21— Hamilton to Port Arthur with package freight	120 tons	120 tons
Trip No. 22— Port Arthur to Buffalo with grain	126,480 bu.	126,928 bu.
Trip No. 23— Buffalo to Hamilton with coal	3,388 tons	3,400 tons
Trip No. 24— Hamilton to Tadousac, light	.....	.....
Trip No. 25— Tadousac to Welland with pulpwood	1,200 tons	1,200 tons
Trip No. 26— Welland to Oswego, light	.....	.....
Trip No. 27— Oswego to Toronto with coal	3,388 tons	3,400 tons
Trip No. 28— Toronto to Ashtabula, light	.....	.....
Trip No. 29 Ashtabula to Port Arthur with coal	3,388 tons	3,400 tons
Trip No. 30— Port Arthur to Iron Mountain, light	.....	.....
Trip No. 31— Iron Mountain to Hamilton with iron ore	3,388 tons	3,400 tons
Trip No. 32— Hamilton to Quebec with package freight	320 tons	320 tons
Trip No. 33— Quebec to Sydney, light	.....	.....
Trip No. 34— Sydney to Port Arthur with coal	3,388 tons	3,400 tons
Trip No. 35— Port Arthur to Duluth, light	.....	.....
Trip No. 36— Duluth to Hamilton with iron ore	3,388 tons	3,400 tons
Trip No. 37— Hamilton to Point Anne, light	.....	.....
Trip No. 38— Point Anne to Toronto with crushed stone	3,388 tons	3,400 tons
Trip No. 39— Toronto to Oswego, light	.....	.....
Trip No. 40— Oswego to Hamilton with coal	3,388 tons	3,400 tons
Trip No. 41— Hamilton to Montreal with package freight	320 tons	320 tons
Trip No. 42— Montreal to Port Arthur, light	.....	.....
Trip No. 43— Port Arthur to Port Colborne with grain	126,480 bu.	126,928 bu.
Trip No. 44— Port Colborne to Montreal with grain	84,000 bu.	89,000 bu.
Trip No. 45— Montreal to Port Arthur, light	.....	.....
Trip No. 46— Port Arthur to Port Colborne with grain	126,480 bu.	126,928 bu.
Trip No. 47— Port Colborne to Montreal with grain	84,000 bu.	89,000 bu.
Trip No. 48— Montreal to Port Arthur, light	.....	.....
Trip No. 49— Port Arthur to Port Colborne with grain	126,480 bu.	126,928 bu.
Trip No. 50— Port Colborne to Montreal	84,000 bu.	89,000 bu.
Trip No. 51— Montreal to Port Arthur, light	.....	.....
Trip No. 52— Port Arthur to Port Colborne with grain	126,480 bu.	126,928 bu.
Trip No. 53— Port Colborne to Montreal with grain	84,000 bu.	89,000 bu.
Trip No. 54— Montreal to Port Arthur, light	.....	.....
Trip No. 55— Port Arthur to Buffalo with grain	126,480 bu.	126,928 bu



Typical Great Lakes steam-driven freighter upon which the operating data on this page is based

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OIL-ENGINES IN THE WORK-BOAT FIELD

ECONOMY and reliability, also the increased profits due to decreased operating and maintenance costs, are responsible for the increased use of ocean-going motorships. These same factors apply to smaller boats and installations just as forcibly and are responsible for the transition from steam to oil-engines in the smaller coastwise and harbor-craft which is taking place much more rapidly than many among us realize. The principles of economics rule in every line, large or small, and no blind shutting of boat owners' eyes to the facts of this or any development can affect the inevitable result. The oil-engine is entrenching itself in our harbor and coastwise-fleets; in a very few years we believe that a steam-driven harbor-lighter or tug will be a misfit, and so great a source of loss to its owner that it will not be able to operate in competition with the oil-engined vessel.

If the owners of big steamships cannot operate at a profit against motorships—and even the enormous resources of the Government cannot afford to keep our steamship fleet in operation against Diesel-driven vessels—how can the owner of the small steam-vessel expect to compete against the more economical motor craft? We all know that a small steam-plant is not relatively as economical as a large one because of several reasons, chief among which are that the short, full-bodied small vessel is more wasteful of power than the easy-lined, longer vessel; the more intermittent service renders long stand-bys necessary; the engine and fireroom crews of the small boat are not, as a rule, quite as efficient or well-disciplined as those of large-vessels; small-vessels do either constant or frequent towing of other vessels, which work consumes more fuel than straight-away running of the steamship—therefore, the owner of the small steam-vessel must watch his balance-sheet pretty closely. A dollar to him is a larger proportion of his investment, of his expenses and of his income than it is to the big company operating a large vessel or fleet. He must conserve his capital. If he can keep his operating expenses down, he can succeed.

Wherever the heavy-oil engined tug, lighter, passenger or cargo-vessel has been operated alongside of a steam, gasoline or distillate-engined boat it has been clearly demonstrated that she has done equal, in many cases much better, work always at less cost of operation than her less economical sister. In the smaller sizes of oil-engines, say up to two or three hundred horse-power, manufacturers can find a field in our harbor, and coastwise fleets that will absorb many hundreds of engines. Not only is there a big market, but the manufacture of the small engine is easily standardized, experimental work costs less than with big engines, and selling expense is lower, while scores of good men are available to operate these engines. Such small oil-engines are daily increasing in number, in efficiency, and in the respect of the commercial boat world.

Part of "Motorship's" work is to assist in this development of an economical harbor and coastwise oil-engined fleet, by giving publicity to actual results obtained, by giving technical service to owner, the builder, designer, operator and engine manufacturer, in a manner that will promote the best interests of all.

FINANCING STEAMSHIP CONVERSION

VERY favorable criticism has followed the publication of "MOTORSHIP'S" plan for conversion of a number of the Shipping Board's steamers to motor power, and the only obstacle likely to cause a delay in its early and effective completion is the question of finance. It is true that under the proposal outlined an owner will secure a modern, well-equipped, and economical Diesel-driven freighter at a cost equivalent to the cost of similar motor craft in Europe. But, even then the matter of finding sufficient funds offers a serious problem to all except the largest and wealthiest shipowning concerns.

This factor "MOTORSHIP" had taken into careful consideration at the time of preparing the conversion plan, and has suggested to the Board and to leading Congressmen a financing scheme that has much to commend it. We have proposed that Section Eleven of the Jones Act shall be amended to a sufficient extent to allow the Board to advance at about 4½ per cent annual interest two-thirds of the necessary amounts, payable within, say, five years in semi-annual installments. Congress to authorize and provide a special loan-fund for this purpose. The Board to hold mortgages on the ships to ensure that the debts be refunded, and to charter or sell vessels over to other owners if the shipowner fails to meet the loan and interest.

In this manner shipowners will be greatly encouraged to take the ships off the Board's hands without further expense to the Government. In fact, at a profit to the Government, as the Board may receive quite a substantial cash payment in each case, according to the amount and cost of work on each individual ship. In a few rare instances the cost of conversion and re-conditioning may be very high. But such vessels had best be sunk or scrapped if their condition is that bad.

Under this arrangement we assume that to convert an 8,800 tons d.w. steamer to Diesel propelling power, and electric deck-machinery will cost about $400,000. A similar but new vessel purchased abroad will cost anywhere from $450,000 to $525,000 to-day. Some officials believe the cost of conversion will be $500,000, others say $350,000. This means that the price the shipowner will pay the Board for the steamer upon conversion will be from $50,000 to $110,000, making the total cost of the converted ship to him from $450,000 to $510,000. Costs of every individual ship may differ in accordance with the amount of re-conditioning necessary.

Already the Board has started action on the conversion idea, and on December 11th the following letter was sent to leading shipowners and shipbuilders by J. W. Powell, President of the U. S. Shipping Board, Emergency Fleet Corporation, Washington, D. C.

Gentlemen:

The United States Shipping Board Emergency Fleet Corporation is advertising for sale under this date twenty of its ships that will be sold to the highest bidder guaranteeing, under satisfactory conditions, the installation of a full Diesel-engine equipment in place of the present power plants. In choosing the types of vessels, especial care has been taken to select hulls that are well built, and that represent in type a highly desirable design of cargo steamer.

It is the belief of the Trustees that shipbuilders or ship-operators can pay a sum for these vessels which, added to the cost of the Diesel installation, will produce the very best type of modern tonnage and at a total cost as low as this type of vessel can be purchased today in the world market.

It is hoped that the result of this sale will go to further the development of all of the various types of Diesel-engines that have now passed the experimental stage, and your consideration of and interest in this proposition, which is of very real importance in the development of the American Merchant Marine, is earnestly requested.

Very truly yours,
UNITED STATES SHIPPING BOARD EMERGENCY FLEET CORP.,
(Signed) J. W. Powell, President.

Apparently at least two departments of the Board are at work on the conversion programme, the foregoing apparently being the Fleet Corporation's plan. Considerable investigation work is also being carried-out by Rear-Admiral Benson and his staff, who plans to obtain authority and funds to enable the Shipping Board to convert twenty steamers to Diesel power as an initial test and guidance to owners prior to turning them over to private shipowners. Further development on both these lines is awaited with interest.

We understand that the Board will recommend having Section Eleven of the Jones Act changed to enable the Board to use the authorized new construction fund available for conversion of steamers, which calls to mind a final hour recommendation made by "MOTORSHIP" to the Senate during December 1920, namely that Section Eleven be changed to read as follows:—

"That during a period of five years from the enactment of this Act the Board may annually set aside out of the revenues from sales and operations a sum not exceeding $25,000,000, to be known as its construction loan fund, to be used in aid of the construction of vessels of the best and most efficient type for the establishment and maintenance of service on merchant-ship lines deemed desirable and necessary by the Board, and such vessels shall be equipped with the most modern, the most efficient, and the most economical machinery and commercial appliances. The Board shall use such fund to the extent required upon such terms as the Board may prescribe to aid persons, citizens of the United States, in the construction by them in private shipyards in the United States of the foregoing class of vessels. Furthermore, the Board may use such available part of this fund for the purpose of changing, or assisting American shipowners in changing existing American merchant-vessels whereby they shall be converted from a possible un-economical and inefficient type to the most modern, the most economical and the most efficient type as approved by the Board. No aid shall be for a greater sum than two-thirds of the cost of the vessel or vessels to be constructed, or two-thirds of the cost of re-construction, and the Board shall require such security, including a first lien upon the entire interest in the vessel or vessels so constructed as it shall deem necessary to insure the repayment of such sum with interest thereon and the maintenance of the service for which such vessel or vessels are built."

Unfortunately part of the House was opposed to Section Eleven; so adoption of the late hour change at that time would have endangered it passing Congress. To-day we believe it would pass both the Senate and House with but little opposition if recommended by the Shipping Board.

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Future Design of Two-Cycle Marine Oil Engines

Methods of Improving Present Practice for Better Efficiency and Overcoming Existing Weaknesses

CLEAR and undisputed are the contentions of the four-cycle advocate in making out the shortcomings of the two-cycle oil-engine. The charges against the delinquent, by comparison to the four-cycle engine, are:

First—In its double power cycle it furnishes only one-and-three-quarters times or less of power of the corresponding single power cycle of the four-cycle engine.

Second—Loss of fresh air through exhaust ports.

Third—Lower M.E.P.

Fourth—Much hotter cylinder.

Fifth—Increased oil-consumption for the lubrication of the cylinder.

Sixth—Overheating of exhaust passages and many others of minor importance. The two-cycle man has to acknowledge all of this, but he can also point out that the four-cycle engine is older and has been worked out much more carefully and much more scientifically. This leads to the question: What may be the future development of the marine two-cycle engine and could it not be brought to a much higher level of performance than is today the common, average practice, disregarding a few unusually excellent examples?

Analyzing the aforementioned differences, the ultimate fundamental cause of inferiority will be found in the degree and in the quality of scavenging and refilling of the cylinder with fresh air. It is probably clear to almost all engine designers that the future high quality performance of the two-cycle oil-engine hinges mainly on 85 to 90 per cent of fully oxygenized, fresh air in the cylinder instead of the usual 60 to 65 per cent, which sometimes with a leaky crankcase and bearings may sink to 40 or 45 per cent of the stroke volume. The designer of a two-cycle engine is thus face to face with the problem: How can scavenging be improved?

To determine how to improve and where to improve, one must familiarize one's self with the points in which the present systems are weak. The results perhaps may be generalized as follows:

(a) Stroke volume of scavenging-piston is too small.

(b) Phase of scavenging effect is not timed right.

(c) Pressure effect is not uniform, not allowing well maintained stratification, starting with a certain pop and reproducing only an ineffective whirl, leaving inert gases which delay prompt and correct ignition and combustion.

It deserves to be pointed out at this stage that there are very successful systems of scavenging in use at the present time. This refers particularly to the Koerting two-cycle gas engine. In this engine very careful stratification has to be realized due to the possibility of pre-ignition of the mixture of air and gas by remnants of exhaust gas. Numerous plants with Koerting gas-engines undoubtedly prove the success of the system. All three conditions, a, b, and c, are fulfilled in this engine, as

(a) The stroke volume of the scavenging-piston is large.

(b) The phase difference between cranks is 110 degrees, air being supplied during part of instroke and also part on outstroke of engine piston near dead centre.

(c) Pressure effect is practically uniform, the air piston moving at practically uniform and maximum speed at mid-stroke position.

Unfortunately such careful design has seldom been bestowed upon two-cycle oil-engines. The usual scavenging system may properly be divided into two classes:

1. Air admission by cylinder-liner ports actuated by piston edge.

2. Air admission by cylinder-head valves actuated by special valve-gear.

In 1, it is necessary, to effect perfect performance, that the fresh air should beat its way clear through the exhaust gases to the end of the cylinder to realize a reasonable stratification. In 2, the fresh air is all introduced at the end of the cylinder and assumes the desired stratification very much more naturally, as exemplified in the Koerting engine.

Considering the desirable characteristics for introducing the scavenging-air, it is found that the different methods should bring the air to:

(a) Such volume

(b) Such pressure

(c) Such velocity

(d) Such uniform continuity of velocity, as will satisfactorily and economically drive out the entire exhaust-gas volume.

The available means usually employed for securing these qualities in the compressed scavenging-air are:

1. Closed crank-case.
2. Step piston.
3. Special piston-pumps, driven by a swing lever or by crank or eccentric.
4. Special blowers.

Analyzing the average performance of these four scavenging methods in reference to the aforementioned four qualities, a, b, c, and d, it is found that:

1. The closed crank-case is rather handicapped in the correct fulfillment of these requirements. It can have theoretically no larger stroke volume than the working-piston has. Considerable losses will reduce this effective stroke-volume to 60 or 65 per cent and with leakage even to 40 per cent, compressing at the same time into the volume of the case, often more than two or three times its own volume. It is not surprising therefore that sometimes perhaps only 1 or 1½ pounds gauge pressure are realized before the port into the cylinder opens. Scrutinizing light spring cards one finds usually at the opening of the exhaust-port up to 30 or 35 pounds gauge pressure. The pressure has fallen to perhaps 8 to 10 pounds at the time when the air port opens, steadily falling further to about 1 or possibly ½ pound gauge terminal pressure.

It is probable that little air will come in at the opening of the air port, while unfortunately the piston will discontinue pushing the air and imparting velocity to it altogether when it gets to the end of its stroke. It is the most serious drawback of the crank-case, that the piston is effective only on the outstroke, or one-half of the time that the air-port is open. A still further detriment is that it has a suction effect upon the open port in its beginning instroke or the second half of the admission port. It is unfortunately correct that the crank-case compression is absolutely deficient in all four qualities.

2. It must be admitted also that the usual step-piston suffers from the same defects, although here is at least the possibility of making it extra large and thus gaining an excess of volume which can ameliorate matters somewhat but like the underside of the piston in the crank-case it is inseparably tied to the working-piston and from its resulting phase can be effective only during the outstroke or one-half of the available time for scavenging.

3. A number of fine examples of two-stroke oil-engines of European make are employing reciprocating scavenging-pumps, independent from all or some of the working cylinders. They are either driven by a swing-beam or by special crank on the main engine. These arrangements allow the possibility of sufficient volume and of sufficient pressure but if operating in unison with the working-piston they are liable to be deficient in having the velocity varying too much or maintaining it sufficiently long. They are thus not effective during the entire period of the port opening. Any reciprocating pump system of scavenging has a difficult task under the very, very short time allowance for the introduction of the air.

Assuming for example that the arc of the crank-shaft during opening of the air-port or valves is perhaps 90 degrees or one-quarter of one revolution, then at 120 r.p.m., one revolution requires one-half second and the air-port would be open only ⅛ of one second. Probably this consideration induced a number of the prominent European builders to prefer head valves to liner ports because a regular valve gear can be timed rather more correctly than port openings.

4. One further possibility remains to be discussed, viz., the employment of a rotary blower. It must be admitted that a rotary blower of the Root or Turbo centrifugal type can provide all four qualities satisfactorily. It can realize volume, pressure, velocity and the velocity in uniform continuity during the entire time of the opening of either air ports or valves. Blowers can thus fill all requirements that are made upon it in regard to quantity, phase, and uniformity or maintenance of flow of scavenging-air. This satisfactory performance can be realized also by driving the blower either direct from the engine itself or from a separate agent.

Particularly for larger machines such a blower arrangement would be exceedingly convenient as the absence of a crank-case would enable the designer to shape the frame of the main engine in such form that better structural strength may be obtained. There is then no necessity to secure air tightness, closeness or fastenings or freedom from contamination by flying oil and a great many other considerations that at the present time are a considerable handicap toward rational, efficient and cheap execution of the framing of oil-engines with crank-cases.

Marine practice has for a number of years clearly indicated the tendency of driving auxiliaries, which at the present time in steam practice are almost exclusively independent and this will be found in a similar way exactly the desirable arrangement also for marine oil-engines. It will be seen that this is an advantage for the two-cycle engine as blowers can be arranged in relatively small size running at high speed, perhaps driven by electric-motors or otherwise by small fast-running oil-engines, and allowing the main engine to be provided with scavenging-air under the most advantageous conditions. The independent blower will bring the two-cycle principle very much more to the front for marine engines because thereby it will be possible to realize an excess power production or overload out of the main engine. This at the present time, as every engine designer knows, is a very difficult thing to realize. The difficulty has been to introduce sufficient oxygen into the cylinder for the purpose of burning the oil and so far no means has been devised by which it has been possible to alter this volume of oxygen and air.

The independent blower furnishes a means to do this. Its volume as well as its pressure of output can be raised by increasing the number of revolutions, thus getting not only more air through the cylinder, scavenging more completely, but leaving the air in the cylinder at greater density and containing more oxygen relatively per cubic-foot of volume. Much air is lost and wasted at the present time by allowing it to escape too early and often by its path blocking off volumes of exhaust gases that thereby lose the possibility of passing out into the exhaust port. Thus a very poor mixture is realized, that is largely the reason why the two-cycle engines have shown themselves with such poor economy and with such poor power production.

Some experiments which the writer made with some small two-cycle engines proved very conclusively that the height of the baffle-plates on top of the piston has a great deal to do with the efficiency in the use of the scavenging-air. It was found that the low baffle-plates which had been placed and installed at first, allowed the air to escape over the top of the piston and directly out at the exhaust-port. This was found by lifting the cylinder-heads about an inch up from the face of the cylinder and introducing small strips of paper on different sides of the gap. It was found with the low baffle-plates that the strip on the same side where the air-inlet was, deflected down and the strip opposite on the side where the exhaust-port was deflected up. This showed that the air did not pass up straight on the side of the cylinder-wall of the exhaust-port but deflected across and struck the cylinder-wall on the exhaust-port side. The baffle-plate was changed and made twice as high, so that now its upper edge was above the top edge of the air inlet-port. Thus, the air was forced to deflect straight up and it was found now that the paper strip on the air inlet side deflected

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up and the one on the exhaust-port side deflected down. Consequently, it showed that the air traveled all around on the outside of the cylinder-wall and underneath the heads and down into the exhaust-port, completely scavenging and scouring the stroke volume.

In the further development of these experiments it occurred that a double inlet would be still more effective, both of them set down deep into the body of the piston so that from two very contracted air inlet-ports the air precipitates directly up, beating through the exhaust-gases right to the top without deflection until striking the cylinder-heads and meeting each other, thereby losing their velocity and now in uniformly spread-out layers behind the exhaust-gases pushing them, which find their exit through two opposite ports of as wide a circumferential dimension as possibly can be arranged.

It is possible to continue the action of the blower as long as the air port is open. It is also readily seen that it is not necessarily confined to pressures of one or one and one-half pounds gauge pressure, but that it is quite possible to run the blower so that three or four pounds and for overload production five or six pounds gauge pressure are realized. Undoubtedly such an arrangement could materially contribute to a largely increased efficiency of the two-cycle marine-engine.

Aside from the blower for the production of scavenging-air, it is well to consider the double-acting air-pump, or pressure-pump. This has proved quite efficient and economical in the production of the compressed air for scavenging purposes even to as high as ten or twelve pounds. It should be pointed out that as good an arrangement can be realized from these double-acting pumps as can be from the blower, provided that one double-acting pump will only supply two cylinders and be so arranged that the pump is at the middle of its stroke moving at its maximum velocity and volume displacements when the cylinders have their working-pistons at the end of their strokes.

Thereby it is possible to gain an arrangement similar to the arrangement of the blower which enables a supply of scavenging-air from the very beginning of the opening of the inlet ports or of the valves in the head to the very last moment when they close, because in each case the piston of the double-acting pump travels all the time ahead in displacing air at its greatest capacity, it being phased by about 90 degrees to the working pistons of the cylinders and being enabled to realize this in the same way as in the Koerting two-cycle gas-engine with its air and gas pumps. There is realized thereby full-volume, full-pressure and full-continuity of flow, but it is necessary to arrange one double-acting pump for each two cylinders. In a four-cylinder two-cycle marine oil-engine it is quite possible to conveniently arrange the forward pair of cylinders to be supplied by one after pump and the after two cylinders to be supplied by the forward pump, both being driven by swing levers from the cross-heads of the main engine.

There are arrangements where one air-compressor is serving for all the purposes of the Diesel system by having the first-stage cylinder extra large so that it can provide sufficient air at low pressure for scavenging purposes. This scavenging-air from the first-stage cylinder discharges into a receiver alongside the cylinders with branches to each cylinder. Upon further analysis it will be seen, however, that this arrangement may be considered as of doubtful value, because the pump cylinder, discharging perhaps at a time when one cylinder can conveniently take it, will have no further discharge until 180 degrees have passed. But the four cylinders of the main engine are phased 90 degrees, and it will be seen that the cylinder next will not get nearly as much air, because the air in the receiver has already been expended upon the first cylinder, at least the pressure has been reduced so that the second one will not get nearly the same. It is thus doubtful whether full power output will be realized when perhaps only two cylinders will receive the full air and the other two will not get enough.

It should be pointed out that the double-acting air-pumps are not as readily adjustable for different pressures and different volumes as a blower can be made by speeding up its number of revolutions, but both arrangements can thoroughly fill all the demands of the two-cycle engine, provided they are arranged in the proper thoroughly efficient manner. It should be pointed out that the whole scavenging arrangement should be of the strongest and most reliable kind, as it is the one most vital factor for the serviceable condition of the two-cycle engine. Its power and output very largely depends upon the efficiency of the scavenging arrangement. Everything should be of the best, most reliable and adjustable form and the attention given to it should in every way be equal to that bestowed upon the main engine.

It is justifiable under such conditions to think that the two-cycle engine might be so materially improved that it can in every way equal the four-cycle marine oil-engine, at the same time that it can secure the fullest advantage of the greatly reduced weight, space and improved convenience of handling over that of the four-cycle engine. It is purely a question of time and experience that the two-cycle engine will prove itself as the type of oil-engine best suited for the propulsion of ships.

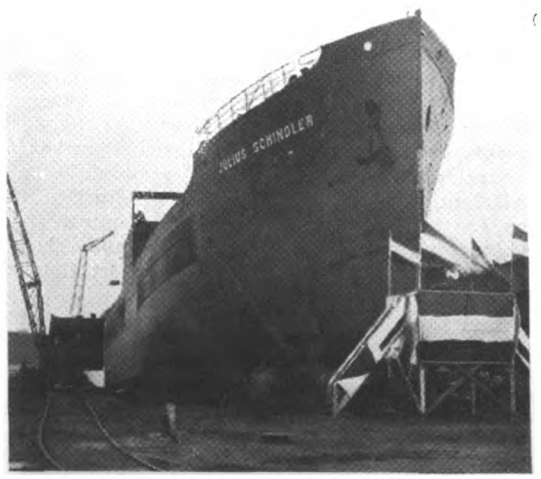
Motorship Building in Germany

Reasons Why Developments and New Construction Have Been Delayed

IN the December issue of "Motorship" there was given a complete list of all motorships built in Germany for German owners since beginning of 1919, that is, practically since the close of the war. This list is not quite complete because neither yards nor shipowners are inclined to give away details on ships, especially on motorships they are building. The number of small motorships and of motor sailing-ships is considerable, but there are until now only very few big motorships completed, and a restricted number under construction. In comparison with Great Britain and the Scandinavian countries, Germany is decidedly behind as concerns motorshipbuilding, but is ahead of the United States as regards motorships under construction. There are indeed some very urgent reasons for this development. Before the war, the oil-engine was just in the experimental stage in Germany. There were a lot of different types, some of which were unsuccessful and brought losses to the builders and owners. During the war the experimental stage of the merchant-ship oil-engine has been overcome in the countries which were able to run ships on the Oceans. In England even the Junkers opposed-piston engine has been developed to a decided success by Doxfords and Cammell-Laird. Burmeister & Wain succeeded in completing their engine to first quality. So did Sulzer Bros. in Switzerland. Meanwhile, the German works built nothing but submarine motors and experimental battleship engines. This development, it is true, was a still greater technical task than that of building merchant-marine motors. But, it did not convince German shipowners that the oil-engine was absolutely safe and a decided economical success. This no doubt is the chief reason for the reserve of German shipowners towards the new type of engine.

Another reason was that of oil shortage. Marine oil-engines should operate most successfully when using gas-oil imported into Germany from foreign countries. With the depreciation of German money value, this became nearly impossible, the price of gas-oil ranging about 6 to 12 times as high as that of German bunker-coal. Thus, it is true it is only of consequence for some ship routes, as it would not be necessary to take all bunkers in Germany and motorships can bunker elsewhere.

Further, the German indemnity laws that have been made in favor of the shipowners, who lost their tonnage in the war, was not at all favorable for the devolopment of motorships. For each ton-deadweight lost, a certain sum was given in order to build a certain fraction of the lost deadweight-capacity. Extras were to be paid by the owners. Of course, as the motorships were dearer per ton-deadweight, owners do not like to take the extra cost on their shoulders. So the payment per ton-deadweight was not at all favorable. But, had it been granted per ton of "effective-cargo," reckoning a certain bunker distance for a certain size of ship, the indemnity would have been nothing but fair to the qualities of the motorship. Since April of this year there has been made a considerable alteration to the indemnity law. All funds destined for the reconstruction of the German merchant-marine have been handed to a trustee bank, and at the same time the total sum has been fixed to 12 milliards. This is a heavy blow for reconstruction work, for of this sum about 5 milliards of marks have been spent already, and the rest only allows the rebuilding of but a very small fraction of what was intended until that date. The consequence was that a great many owners made use of the privilege of handing their contracts to the trustee bank, because they were not able to finish the building with the restricted sums.



Launch of the Diesel-driven tanker "Julius Schindler" at the Deutsche Werft, Hamburg, Germany. To be described in our next issue

Other work has been delayed considerably as the sum has been distributed over a lapse of five years with the object of giving work to the men for long time. It must be considered that the law only secured the consent of the socialistic parties under the condition of avoiding unemployment. As a consequence, the programme of reconstruction has been delayed for years, and work has been stopped on a lot of ships, engines and also Diesel motors, which were handed to the trustee bank. Indeed, even some contracts for motorships have been cancelled by the trustee bank. It is a fact, that the shipowners are not able to build any longer by own means,for the sums saved from freight in 1919 and 1920 have been spent.

All these conditions are adverse to motorship building in Germany. The restriction of German motorshipbuilding is by no means the consequence of technical difficulties.

DEUTSCHE WERFT AND DEUTSCHE WERKE

Regarding the paragraph on page 813 of our October issue, our German correspondent writes:—The Deutsche Werke is a large concern that has taken over all former military and naval works, altogether there are 18 large plants belonging to the company. As concerns marine plants there are the Deutsche Werke, Werft Rustringen near Wilhelmshaven, a former torpedo-boat and torpedo yard; Deutsche Werke, Werft Kiel, the former navy yard and the Deutsche Werke, Werk Friedrichsort near Kiel, a former torpedo plant.

The works at Friedrichsort has been destined to build marine motors of the heavy oil Diesel type. Ships are built at the other two plants and engines installed there. The Deutsche Werft of Hamburg is indeed altogether independent from the Deutsche Werke. Nearly all shares of the Deutsche Werke belong to the State, while the Deutsche Werke is entirely a private company.

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Tar-Oil Fuel for Diesel-Engines

Use of this Oil in Germany.—A Review of the Scientific and Technical Sides of the Question with Special Reference to Practical Solutions Attained in Service.

By DR. ING. CARL COMMENTZ

BEING the native country of the modern Diesel-type heavy-oil engine, Germany, before the Great War, was leading in the technical development of this prime mover. There were in 1913 about 400,000 horsepower in Diesel engines running in Germany, mostly for stationary work. Also marine oil-engines had been built up to about 2,000 horsepower per engine. Development of the Diesel-engine for power producing purposes was nearly entirely stopped in Germany at the outbreak of the war with exception of the high-speed marine-engine for war-craft including submarines and for auxiliary purposes on big ships.

The reason for this sudden stoppage is a simple one: Germany was producing only a part of the oils which were necessary to drive the existing engines. Indeed, of a total of about 105,000 tons of heavy-oils consumed annually in Diesel engines, there were 55,000 tons of gas-oil, most of which was imported, about 12-15,000 tons, however, being paraffin-oils distilled from brown coal; the balance of 50,000 tons was made up by tar-oil distilled from bituminous coal. So at the beginning of the war, when nearly all imports ceased, there was but one thing to do, viz. retain the produced paraffin-oil for military and naval purposes and to reduce the number of engines running.

Extensive use of tar-oil before 1914 was the result of prices. Imported gas-oils and paraffin oils cost about 100 to 120 marks per ton, the import duty on crude oils being 36 marks per ton, while tar-oil cost about 40 to 50 marks; questions of transport varied these prices to a degree at different places. For marine purposes, where there was no import duty only gas-oil was used. These factors made it imperative that the difficulties met when first using tar-oils be entirely overcome. In fact they had been overcome before the war for a great many types of oil-engines and purposes, as may be seen by the total consumption given above.

The advent of war brought an unexpected development of the high-speed Diesel-engine; this technical development was such that all constructive details now have been worked out almost to perfection in Germany. The only point not in keeping with other advances was the use of tar-oils with this type, as all efforts were concentrated upon the design and construction of the engine itself, which could not be used with tar-oils for military purposes, the risk of difficulties being too great.

Since the end of 1918, however, German engine-builders have made this subject a point of special study, and notable progress has since been made, though the development of oil prices has been not at all encouraging. In the last quarter of 1920 the European prices for gas-oil were about three times as high as 1913; in Germany, as a consequence of the low money value they had risen to about 300 marks, or 22 times as high. At the same time, tar-oil costs 290 marks or more than sixty times as much as in 1913. This is due to the extreme shortness of fuel-oils in Germany by the falling-off of production of coal, and to the deliveries of coal and tar products by Germany to the Entente.

Lately, however, the prices have dropped a little. But owing to the prices still being exorbitant when compared with the price of coal (which has only risen to 15 times as much as 1913) the distillation of coal has been extended considerably and new and efficient methods been developed for this process. Indeed, the economical revolution will result in a larger proportion of coal being distilled in Germany in the near future. Gas firing has been extensively adopted in industrial works of late, the new method of distilling bituminous coal at low temperatures producing a very good tar-oil, and half coke will be introduced on large scale for railway purposes. With this development the price of tar-oil will fall considerably, particularly in comparison with the present price of imported gas-oil and even when compared with coal. Consequently the Diesel engine will again take its place as the most economical prime mover if driven by tar-oil. It will, however, be a question whether it will be able to compete in Germany with modern coal-burning stationary steam-plant if imported gas-oil has to be used. For the same reason, Germany will be compelled to construct marine oil-engines for the use of tar-oil. These facts are the reason for the amount of work recently applied to the improvement of tar-oil burning engines.

The principal difficulties experienced with the use of tar-oils in Diesel-engines were obvious from the first trials. At the normal compression of 35 to 40 atmospheres (500 to 560 lbs. per square-inch) reliable running of Diesel-engines was only possible if the engine was warm and constantly running at its normal power; even under these conditions there were difficulties with small units and fast running types. The engines best suited for tar-oil were large slow-running types operating at constant speed and power, such as for generating electricity. Starting had to be made with another oil. The technical reason for these difficulties is the chemical constitution of tar-oils, which is widely different from that of gas-oils. They are more difficult to decompose and require more heat for this process; therefore the ignition of tar-oil requires a higher temperature and consequently a higher cylinder pressure than hitherto used. This could not be applied because all parts of the engines had to be considerably stronger as the heat was too great to be endured by the metal. Therefore other methods had to be sought.

Trials were made with a mixture of gas-oil and tar-oil. This measure proved to be successful, if about 50% gas-oil was used. But this practice resulted in only half of the desired economy. Other devices were tried, which will be described later on; the most successful being the use of gas-oil as ignition-oil and as starting oil. This measure at first involved constructive and running difficulties, which have now been mostly overcome. The use of tar-oil is a problem which has been solved in a practical way, rather than by theoretical and scientific research. But the work spent upon this task has been very wearisome; hundreds and thousands of trials had to be made on the engine-builders' test-beds before success was attained. Many alterations were necessary, especially with the injection-valve and the pulverizer. Different oils behaved differently. Scientific researches were made to ascertain the properties of tar-oil best suited for Diesel oil engines. Only a complete knowledge of chemical and physical composition and behaviour of the oils led to the best constructive measures and selection, of the most suitable oils. On the other hand, this knowledge favorably influenced the quality of tar-oils. Difficulties of this research were considerable; the main one being that it was impossible to burn and to investigate the oil under the same conditions as they are burnt in the cylinder of the engine, namely, under a pressure of 35 to 40 atmospheres (500 to 560 lbs. per square-inch). To give a complete aspect of the questions which had to be solved, and to show the results, it is necessary to give a review of the principal scientific investigations on the use of tar-oils. In most cases they were made by comparison with gas-oils; so it is necessary to consider also some of the properties of gas-oils.

The tar, from which the tar-oil is distilled, is made in vertical, inclined and horizontal retorts. This tar, in the normal German process of distillation, is split-up into five products, according to the temperature of distillation, namely:

(1) Light-oils distilled at a temperature up to 170°C (350°F).

(2) Medium-oils distilled at 170-230°C (350-450°F).

(3) Heavy-oils distilled at 230-270°C (450-520°F).

(4) Anthracene-oils distilled at 270-350°C (520-660°F).

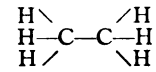
(5) Residues (pitch).

The products used as Diesel-engine oils are mixtures chiefly of heavy and Anthracene oils, containing also a small percentage of middle oils, as the technical processes are different and do not exactly divide the oils.

The first deeply scientific research was made by Dr. Rieppel in 1907. He tried various oils on the market in a M.A.N.-Diesel engine of 35 horsepower, and investigated the physical and chemical properties. Gas-oils gave no difficulties whatever. Paraffin-oil could also be used in general. As to specific gravity, viscosity, flash-point and ignition-point they had no characteristics by which their suitability could be judged. But the chemical analysis gave some certain indications which must be looked upon in detail, as this has proved to be the principal matter. Gas-oils as well as tar-oils consist of hydrocarburets, but of different kind. Gas-oil hydrocarburets are of aliphatic nature, the formulae being of the form

$$C_nH_{2n+2},\ C_nH_{2n},\ C_nH_{2n-2}$$

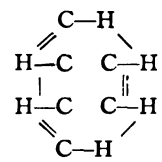
and so on. They are in their composition like chains, for instance



If high temperature and air act upon this chain, it is decomposited, the hydrogen burning to water, the carbon to carbonic acid. The hydrocarburets of the tar-oils are of aromatic nature, the formulae being:

$$C_nH_n,\ C_nH_{n-2},\ C_nH_{n+4}$$

and so on. It is obvious from the formula that there is much less hydrogen in these hydrocarburets. But the principal difference is, that all atoms are bound together in the form of a ring like benzol:



If high temperature and air act upon these rings, they are much harder to decompose than the chains of the aliphatic carburets. Therefore Rieppel was of opinion, that in the Diesel engine, gas-oils are vapourised to oil vapours and these oil vapours are decomposed to oil-gases before being ignited. The first gas to ignite is the hydrogen. Tar-oils, in his opinion are only vapourised before being ignited. In gas-oils there are some little parts of aromatic hydrocarburets, and in tar-oils some of aliphatic nature. The proportion of hydrogen to carbon in the elementary analysis shows the prevailing nature of the parts of an oil. If there is less hydrogen atoms in it than about 140% of the number of carbon atoms, the oil cannot be used without difficulties in oil-engines. By this characteristic all tar-oils were excluded as their atomic proportion is about 0.80-1.20. This opinion was abandoned when the use of gas-oil as ignition-oil was introduced.

Another most valuable investigation was made by Constam and Schläpfer in 1913. As at that time there were running a great many Diesel-engines with tar-oils, they dispensed with engine trials, but investigated such oils as were actually used and the difficulties of which were known. They laid a special stress upon ascertaining the flash-point, the ignition point and the temperature of self-ignition of the oils.

The term "flash-point" is the temperature which the oil vapours must have to ignite when coming into contact with an open flame. The term "ignition-point" is the temperature which the oil itself must have to continue burning when brought into contact with an open flame; in commerce it is generally termed "burning point." The term "temperature of self or spontaneous ignition" is the temperature, which a hot-plate must have to cause ignition of a drop of oil falling on it without any application of open flame. The spontaneous ignition temperature of gas-oils was determined to be about 350°C (660 to 750°F), that of tar-oils about 550°C (920°F). Constam and Schläpfer are of the opinion that tar-oils are only vapourised and gas-oils decomposited before ignition.

(*To be continued*)

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New Sailing-Vessel with Krupp-Diesel-Engine

Four-Masted Barque "Magdalene Vinnen" Combines Economy and Reliability With Beauty

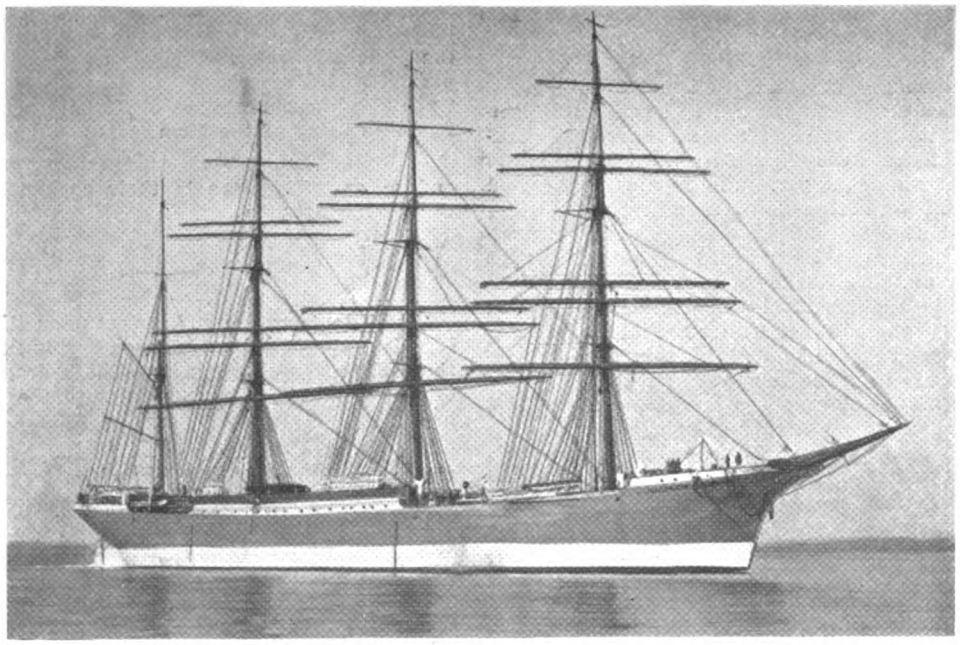
To the lover of the square-rigged sailing vessel the accompanying illustration will appeal very much, for the "Magdalene Vinnen" is a splendid example of this type. With all sail set, bowling along at top speed, "carrying a bone in her teeth," such a vessel would present a sight to delight the eye of the sailor.

But there is another side to the picture. When just off the coast and nearing destination, perhaps, with prospects of an early docking, and discharge of old cargo and taking on new cargo, the wind may suddenly die out, and if the vessel is too far from shore for tugs to be available, or if off a coast where same are not to be had, many hours are lost. A great many harbors are so laid-out that a vessel propelled by machinery can run right up to the dock, whereas a sailing-vessel must resort to the use of tugs for many hours before making the dock. Not only for use in calms and making harbor and docking, but in "clawing-off" a lee shore the auxiliary engine pays for itself many times over.

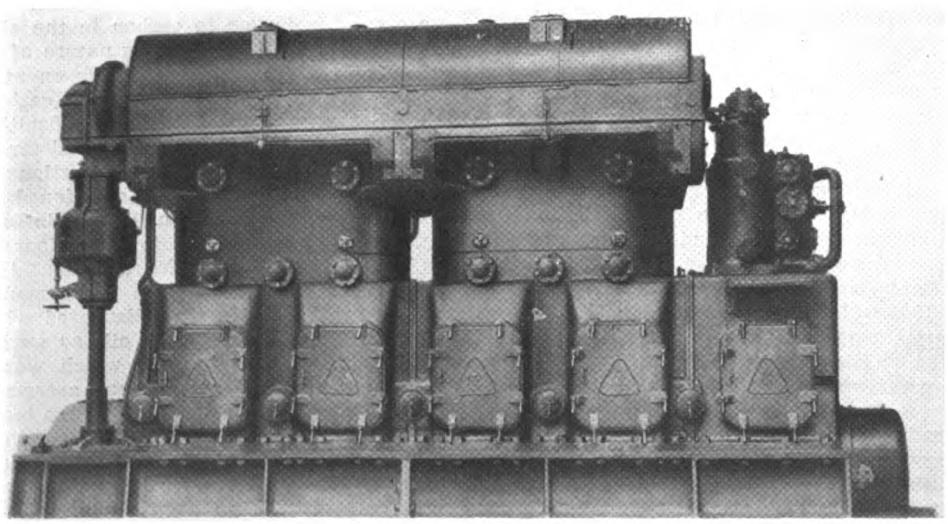
Breadth	48 ft. 6 in.
Depth	28 ft. 6 in.
Draw	24 ft. 6 in.
Sail area	3392 sq. ft.
Speed in ballast	8½ knots
Speed loaded	6½ knots
Horse power, brake	500 h.p.
Revolutions	215 r.p.m.
Deadweight	5200 tons

It will be noted from the illustration that this vessel has been designed essentially as a sailing-ship, with engine auxiliary to sail-power. The three-2½ ton winches are all motor-driven, no steam being used on the vessel. Fuel-oil is carried in tanks holding 110 tons in the engine-room way aft.

We also illustrate the 500 h.p. Germania-type Diesel-engine installed in the "Magdalene Vinnen." This engine is representative of this class, which is built in four different models, ranging from the two cylinder 100 b.h.p. at 190 r.p.m. to the 1,000 b.h.p. model of six cylinders turning at 215 r.p.m. The cylinders are cast "en bloc," two cylinders in one casting with liners fitted, with extra large inspection doors in the totally enclosed crank-case, with forced-feed lubrication-system consisting of lubricating oil-pump, oil-cooler and filter contained within the engine. The mechanically-driven suction-valves of the intermediate and low-pressure stages of the three-stage air-compressor and the mounting of the cam-shaft are entirely independent of the cylinder heads.



The Krupp Diesel-engined four-masted bark "Magdalene Vinnen" of 5,200 tons d.w.c. and 500 b.h.p.



500 b.h.p. Krupp Diesel engine of the "Magdalene Vinnen"

This fine vessel, "Magdalene Vinnen," recently completed for Vinnen & Co. of Bremen by Fried. Krupp, Germaniawerft, takes no chances with wind and sea, for a 500 h.p. four-cylinder four-cycle Germania trunk-piston Diesel-engine is installed way aft direct-coupled to a Germania reversible-propeller, this having been developed from the reversible propellers which this firm originally built. The principle particulars of this vessel are as follows:

Length between perpendiculars.....323 ft.

The Krupp shops are quite busy with construction of these engines, for of the auxiliary class alone Krupp is building 35 vessels, 29 of which are from 115 to 625 deadweight-tons-capacity. Unlike some sections of the world, Germany has taken up the large auxiliary vessel on quite a large scale, even building vessels with hinged masts so that they can run up the rivers and load cargo which they can then transport on deep-sea voyages.

RE RECONDITIONING THE SAN JACINTO

In our November issue we referred to an opportunity being lost when the contract was awarded for reconditioning the steamship San Jacinto by the Ward Line. This vessel, however, is not owned by the Ward Line, but by the Mallory Steamship Co. We are glad to see that the Ward Line are not so ill-advised to spend so much money on installing new steam-machinery when more economical Diesel-power is available.

Marine Diesel-Engine and Semi-Diesel Engine Operation and Management. By Engineer-Lieut. Harold Atkinson, R.N.V.R. Published by E. & F. N. Spon, Ltd., London. Second edition, 1921. Needless to say, every operating engineer should ever be alert to learn everything he possibly can regarding the operation of Diesel-engines, for not only his job but the progress and satisfactory development of the oil-engine depends much on operation. Therefore, this complete and practical treatise should be in the hands of every engineer and those who are training to become one. The practice of Vickers Limited is embodied in the text, but all types of Diesel-engines are treated, as well as Diesel-engine castings, indicator cards, etc. This valuable book can be purchased from "Motorship" at the nominal cost of 80 cents, post free. We have a stock on hand.

COMPRESSED-AIR SIREN FOR MOTORSHIPS

For the purpose of providing an efficient signalling device for motorships, the well-known Swedish engineering and shipbuilding firm of Kockums Mekaniska Verkstads A/B of Malmo, have developed a compressed-air siren from the designs of Helge S. A. Rydberg, which is installed on the Diesel motorships "Balboa," "Buenos Aires," "San Francisco," "Bullaren," "Tisnaren," "Elmaren," and "No. 6 Doxford," also on the steamship "Siljan" where it is used as the sole signalling apparatus instead of the regular steam-siren.

This siren is handled in the U. S. A. by A. O. Andersen & Co. of New York, and is made under American patent 290,297, April 13, 1920. It is different from other diaphragm sirens in that it can be used for steam as well as compressed-air, although the diaphragms are changed and vary according to the pressure at which they will work. For motorships the air-pressure generally adopted is from 120 to 175 lbs. per sq. in., and a minimum advisable pressure of 90 lbs. Very short signals can be given, so that it can be used for code signalling. With a 200 m.m. diameter diaphragm type of siren the average sound-range is about 5½ miles.

NEW MARINE EQUIPMENT CATALOGUE

Condensed Catalogues of Mechanical Equipment, with Directory of Manufacturers. Eleventh Annual Volume, published by The American Society of Mechanical Engineers, New York, 932 pages, 6 x 9. $4.00.

The 1921 volume of this valued reference work for mechanical-engineers has come from the press and is now available for the members of the A. S. M. E. and mechanical-engineers in general. The catalogue section, edited with a view to elimination of advertising claims, comprises seven parts devoted to condensed catalogues of firms of good standing, in the fields of Power Plant Equipment; Testing, Measuring and Recording Apparatus; Power Transmission Machinery; Conveying, Hoisting and Transporting Machinery; Metals, Alloys and Other Materials; Metal Work Machinery, Machine Tools and and Accessories; Compressors, Blowers, Pumps, Hydraulic Machinery, Industrial Machinery, Steel Plate Work. The Directory Section lists equipment of interest to Mechanical Engineers and Consulting Engineers, each section printed on paper of different color. As a reference work this volume should afford a close point of contact between the user and the maker of mechanical equipment.

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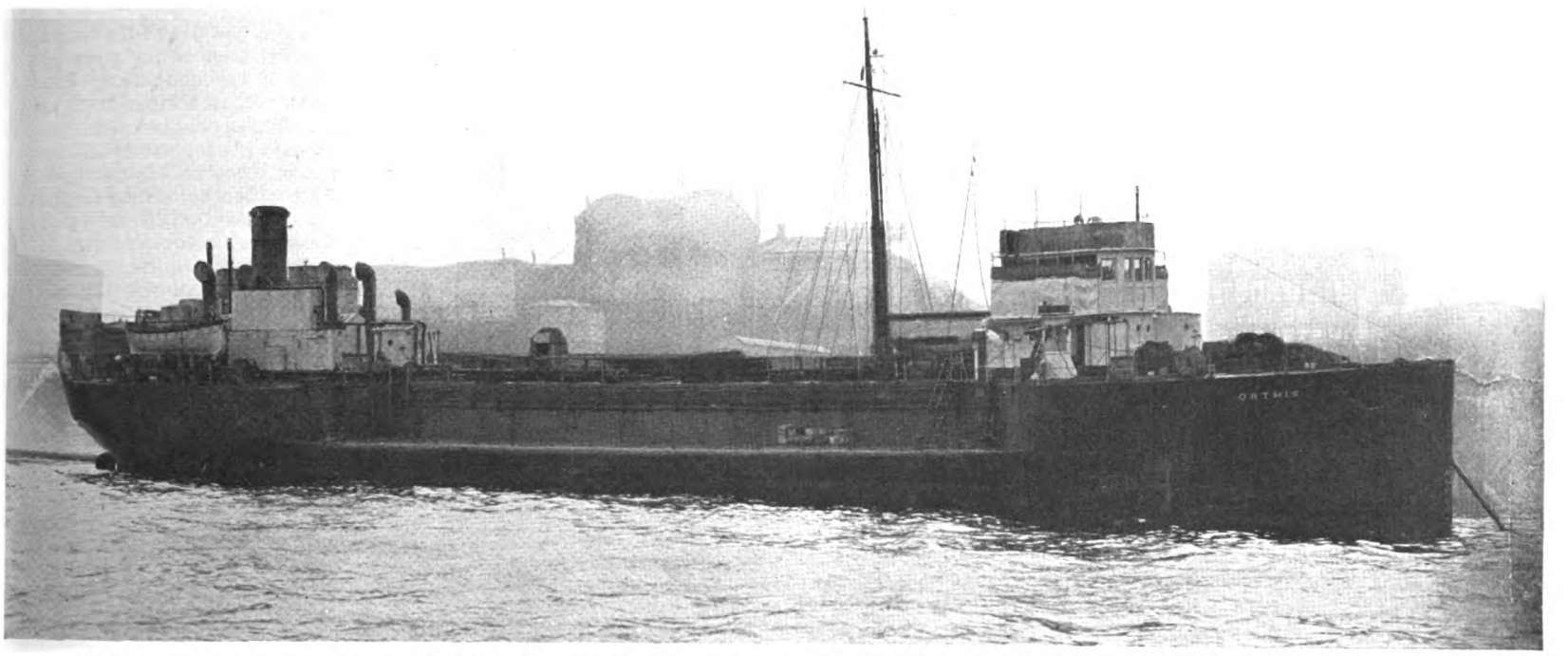
Anglo-Saxon Petroleum Co.'s Motor-Tanker "Orthis"



Motor tanker "Orthis" owned by the Anglo-Saxon Petroleum Co., and pro pelled by twin Bolinder oil-engines of 320 b.h.p. each.

AMONG motorships that have been in service for several years, but which have not been previously illustrated in "Motorship," is the motor-tanker "Orthis," ex "Oakol," a small vessel originally built for the British Admiralty during the war and afterwards sold to the Anglo Saxon Petroleum Co. of London, England. She is one of the numerous Bolinder-engined craft constructed for the British navy, and has the following dimensions:

Displacement (loaded)	2,375 tons
Cargo capacity (heavy-oil)	1,255 tons
or (kerosene)	1,126 tons
Deadweight capacity	1,115 tons
Cubic cargo-capacity	51,257 cu. ft.
Gross tonnage	1,144 tons
Net tonnage	513 tons
Panama Canal tonnage	625 tons
Power	640 shaft h.p.
Speed (loaded)	9¼ knots
Daily fuel-consumption	5 tons
Fuel-capacity	136 tons
Length (O. A.)	219 ft. 9¼ in.
Length (B. P.)	210 ft.
Breadth (O. A.)	34 ft. 8½ in.
Depth (M. D.)	16 ft. 7 in.
Draught (S. W.)	13 ft. 6¾ in.

Her main propelling-machinery consists of twin four-cylinder two-cycle Bolinder oil-engines, each 16 $\frac{9}{16}$ in. bore by 18¾ in. stroke, and having an output of 320 brake h.p. per engine. These engines drive cast-iron three-bladed propellers 6 ft. 6 in. diameter by 6 ft. pitch and 14.26 sq. ft. projected area, and 16.3 sq. ft. expanded area, at 225 r.p.m. We should think that an economy would be effected by means of a better speed by changing to polished bronze propellers. For auxiliary purposes there is an oil-fired Cochran donkey-boiler 16 ft. 3 in. high by 6 ft. 6 in. diameter, having a heating surface of 500 sq. ft. and a working-pressure of 100 lbs. per sq. in. There is a capacity for fresh-water in the forward deep tank, and the aft doublebottom of 87 tons, and 416 tons of ballast water can be carried.

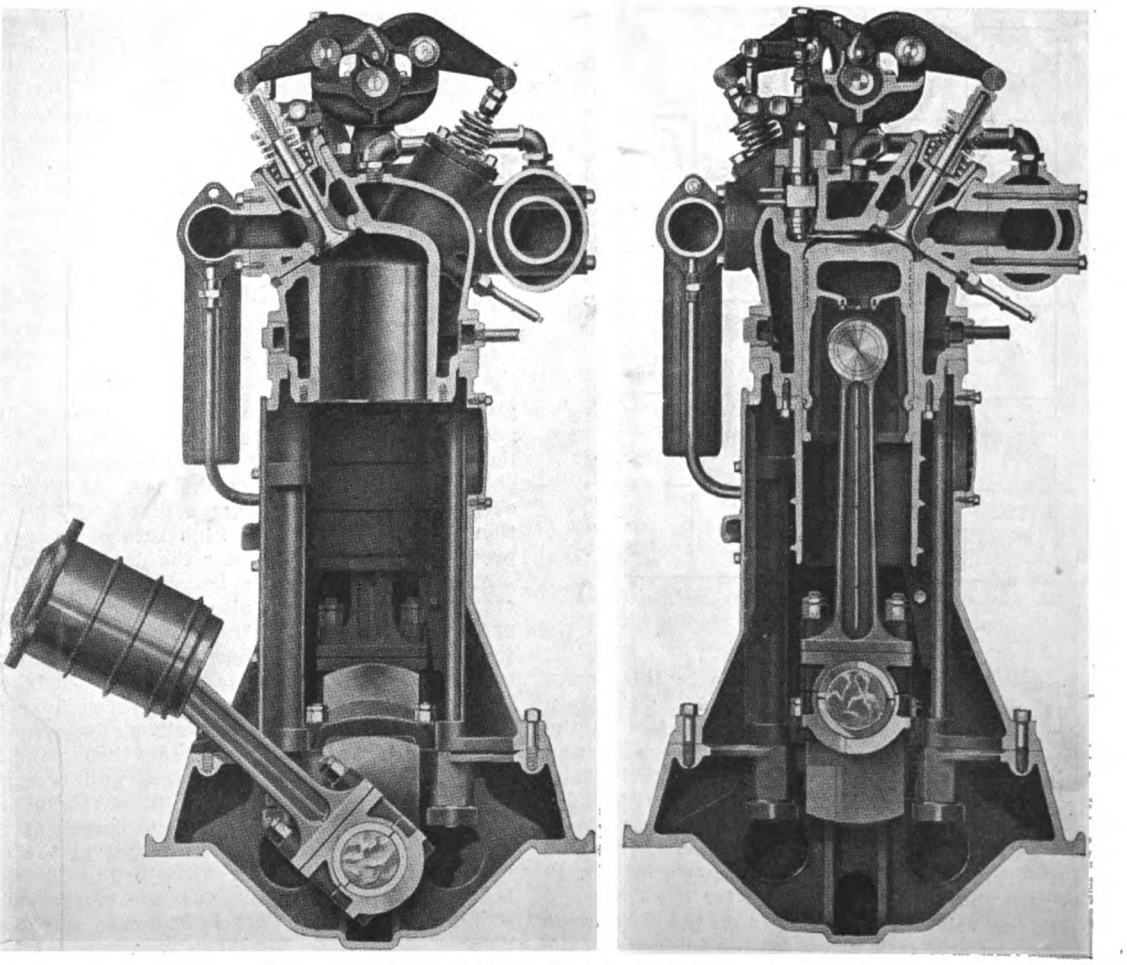
THE LOMBARD DIESEL-ENGINE

A Four-Cycle Marine Motor Designed with Accessibility as a Prominent Feature.

Recently we referred to a new Diesel-type marine engine having been produced by the Lombard Governor Company, Ashland, Mass., from designs by Mr. McCarty, formerly chief-engineer of the Midwest Engine Co., of Indianapolis. The sectional drawings on this page give an excellent idea of the general design, which closely follows the Midwest engine no longer constructed at Indianapolis. Also the piston-dismounting device with the detachable cylinder-skirt originally developed by an engine-building firm in Holland.

With the crank on bottom-center and skirt detached from cylinder casting, any piston with its connecting-rod, can be swung forward through the crank-case door opening, without removing the cylinder-head, disconnecting the crank-pin box, or dismounting the valve-gear or otherwise disturbing adjustments which it is desirable to preserve. Other features of this construction are that it avoids the joint in the combustion-chamber exposed to high temperatures and pressures, the joint between cylinder and skirt sections being subjected only to exhaust temperatures and pressures; it eliminates the metal necessary for a cylinder-and-head joint, thereby securing a much freer movement of the cylinder-wall to take care of expansion and contraction, and providing ample and unrestricted space for circulation of cooling-water, also it permits the accessible, overhead location of cam-shaft with cams running in oil and with valves operated by simple rocker-arms.

The integral air-compressor is of the balanced duplex design for supplying the starting and injection-air. The frame sections which enclose the crank-case merely support weight. Four heavy steel tie-rods extending from each cylinder to the main-bearing pads within the bed-plate, carry the working load and relieve the frame of all tensile stresses. Forced lubrication is adopted.



Sectional views of the Lombard marine oil-engine

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Injection and Combustion of Fuel-Oil

Experiments With Solid-Injection and Air-Blast in Marine Diesel Engines

By ENGINEER-COMMANDER C. J. HAWKES

PART VII.

(Publication delayed through pressure on space.)

(*Continued from page* 820, *October issue*)

THE results obtained with the original fan-shaped sprays at 320 R.P.M. are shown in Fig. 18. It will be seen that the A 16 distributors gave much better results in regard to fuel consumption than the fan-sprays. It was then decided to fit distributors on the lines of distributor A 17, Fig. 17. In this distributor, particulars of which are given in Table 5, each row sweeps the whole of the piston surface and the holes are of more uniform size. The mean results of the series of tests with these distributors, shown in Table 6 and Fig. 18, do not differ in any marked degree from the results with the A 16 distributor.

In all the distributors experimented with the mean distance of the rows of holes from the tops of the adjacent pistons when at the end of the compression stroke was 29/64 inch. It was arranged, therefore, to test distributors with the rows of holes about 9/16 inch from the piston, but otherwise similar in all respects to the A 17 distributors. The fuel-consumptions at the higher mean-pressures were not so good as the consumptions with the A 16 or A 17 distributors. This bears out Professor Junkers' contention in regard to the disposition of the fuel sprays, viz.: that when working at high mean-pressures with the opposed-piston engine it is necessary to arrange the fuel-sprays as close as practicable to the pistons.

In nearly all engines of the opposed-piston type which the author has seen running the injection of the fuel-oil has been accompanied by slight detonation. These engines, however, did not run much above 200 R.P.M., whereas the experimental

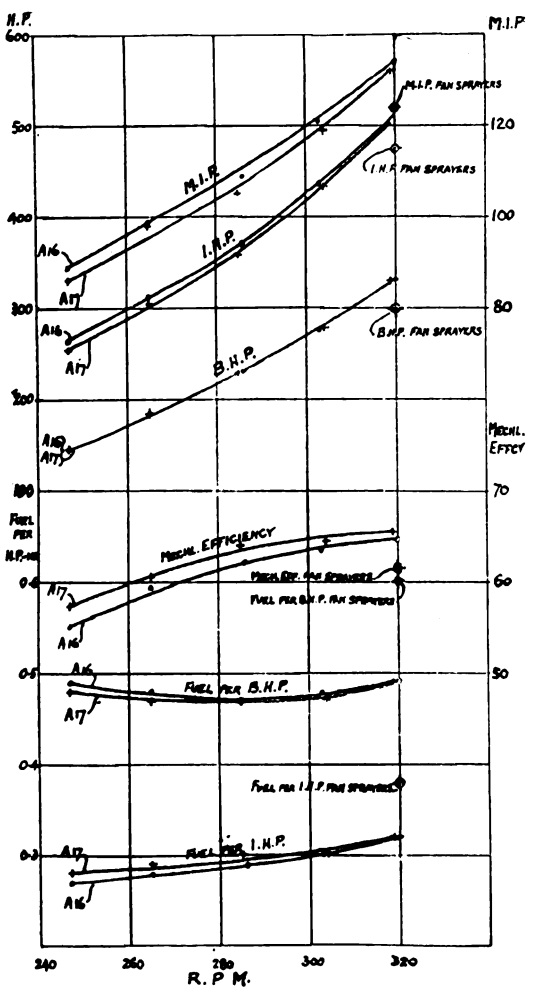

FIG. 18.

opposed-piston engine, referred to in this paper, was run at speeds up to 360 R.P.M. In certain circumstances the detonation of the fuel in the experimental engine was most marked, and although it did not appear to be harmful it would, if heavy, be rather distressing in a multi-cylinder engine of this design.

Three typical combustion diagrams, obtained with various shapes of cams, are shown in Figs. 19 to 21. The valve-lift diagrams for the front and back fuel-valves are also shown on the same angle base. An arbitrary figure for the intensity of detonation and other particulars are given against each combustion diagram. Although in the experimental opposed-piston engine there was no separate timing gear, and therefore it was not possible to modify the "timing" of the fuel-valves when the engine was running, the fuel-cams were adjusted so that the maximum pressure was limited to about 630 lbs. per square inch.

In Fig. 19 with short period cams in use, A B C is the diagram obtained when the engine was running at about 300 B.H.P., but with the fuel momentarily cut off. F A B, therefore, represents, on an angle base, the compression curve, and B C F the expansion of the air previously compressed. The line F G gives the position of the indicator drum corresponding to the inner dead centre, *i e.*, when the pistons were at the end of the compression stroke. A D E represents the combustion diagram. In Fig. 19 the detonation figure is 5 on the arbitrary scale adopted.

In Fig. 20 the cams have a slightly greater period of opening than the cams used in Fig. 21. Fig. 21 is a combustion diagram with long-period cams in use. In this case the fuel-consumption is greater and the detonation less than with the short-period cams.

From the combustion diagrams shown in Figs. 19 to 21 the pressures in *excess* of the pressures

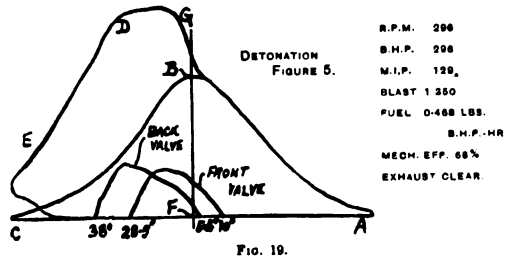

FIG. 19.

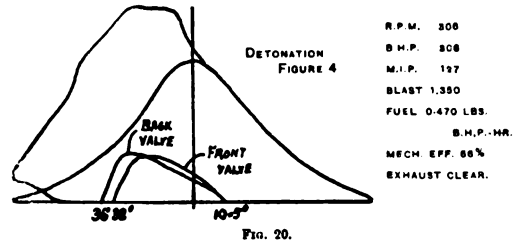

FIG. 20.

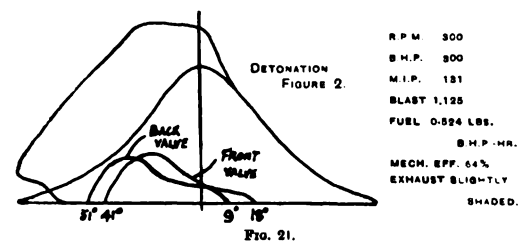

FIG. 21.

given by the no-fuel compression-expansion diagrams were plotted on an angle base, and from these curves the *rates of change* of pressure were obtained. Fig. 22 shows the rate of pressure change curves. It will be seen that heavy detonation is accompanied by a high rate of change of pressure occurring just after the dead centre.

From the combustion diagrams temperature-entropy diagrams were also constructed for comparative purposes, with the assumptions that the temperature of the air charge at the beginning of compression was 200° F., and that the weight of the working fluid was constant throughout the cycle. From the temperature-entropy diagrams the heat supplied and the temperatures throughout the cycle were plotted for each case, and from the heat-supply curves the *rate* of the supply of heat was obtained. Fig. 23 shows the curves of rate of heat supply. It will be seen that in the case of the combustion diagram shown in Fig. 19, where the detonation was heavy, the rate of the supply of heat was greater than in the case of the low detonation diagram, Fig. 21.

From the various diagrams constructed the following points were clearly indicated:—

(1) An increase in the rate of the supply of heat, *i. e.*, in the rate of combustion of the fuel, resulted in heavier detonation.

(2) In the case of low-detonation diagrams heat was being supplied later in the expansion stroke than in the case of the high-detonation diagrams.

(3) The maximum and mean temperatures of the cycle were greater in the low-detonation diagrams than in the high-detonation diagrams.

(4) The thermodynamic efficiency was higher in the case of the high-detonation diagrams than in the case of low-detonation diagrams (this agrees with the fuel consumptions recorded).

From the experiments which were carried out it was clear that detonation was a function of the speed of injection with the particular fuel-oil used, but when working at mean indicated-pressures just above 130 lbs. per square inch an increase in the quantity of fuel-oil injected, other conditions remaining the same, tended to decrease detonation—although in this instance the exhaust did not remain colorless. Also, a reduction in the quantity of fuel injected tended towards decreased detonation.

Texas fuel-oil was used during all these tests. There has been no opportunity to experiment with the object of determining to what extent the intensity of detonation is affected by the brand of fuel-oil used.

Detonation is experienced in aircraft engines, but these engines draw in the fuel charge on the suction stroke, and towards the end of compression it is probable that a fairly homogeneous inflammable mixture is obtained. Ignition in this instance is by spark and detonation is generally attributed to a pressure wave, caused by the ignition of a portion of the charge, compressing the remaining portion of the charge to a temperature above the spontaneous-ignition point of the fuel. On the other hand, in the case of the opposed-piston engine the fuel is injected towards the end of compression into air whose temperature is above the ignition point of the fuel. The mixture of fuel-oil and air which is blown into the compression space through the two fuel-valves is not at first inflammable, and

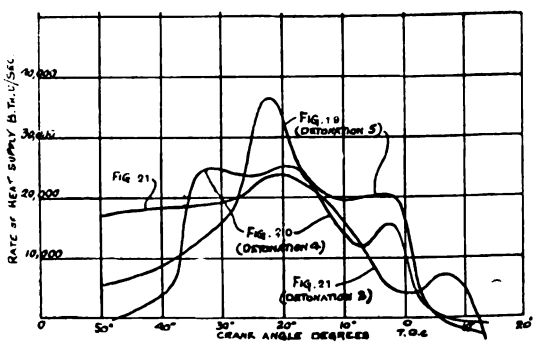

FIG. 23

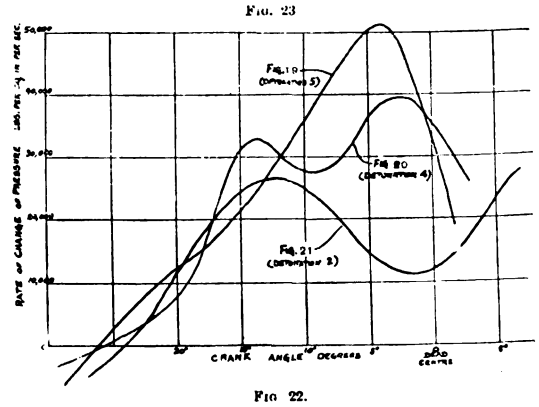

FIG 22.

it seems reasonable to suppose that ignition does not occur until the speed of the incoming charge is reduced, its temperature raised above the ignition point of the fuel-oil and the distribution such that an inflammable mixture is obtained.

When heavy detonation occurs, therefore, it is probable that there is a combination of circumstances favorable to rapid combustion, *i. e.*, by the time the incoming charge of fuel and blast-air has had its temperature raised above the ignition-point of the fuel, either by admixture with highly-heated air in the cylinder, by radiation from the small portion of fuel vapor which commences to burn

(*To be continued*)

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The Motor Work-Boat Field

Prospects for the Small Oil-Engine

MANY of us are aware of the fact that oil-engines of quite low horse-power units are manufactured, even as low as about 5 h.p. in a few cases. In view of the large degree of publicity which must necessarily be given the large Diesel-engine some almost forget that for the smaller sizes of oil-engines there is a field the surface of which has as yet hardly been scratched. Economy of operation—that one big feature about any engine that is paramount in the eyes of the owner because it directly affects his pocketbook—is making the oil-engine in horse-powers of 5 to, say, 500 b.h.p. a real competitor of the gasoline, kerosene and distillate motors, and out-rivaling steam for that purpose.

To definitely state the field of the small oil-engine in numbers of installations likely to be made in small boats is not possible at this time, but that there is a very large field we know. There are no small boats in the harbor and coastwise fleet that oil-engines are not fitted for; by "small boats" we mean tugs, lighters, fishing-boats, oyster-dredgers, passenger-boats, freight-boats, ship-chandlers' service-boats, shipyard service-boats, harbor-works and construction tenders, canal-barges, dredge-tenders, federal, state and municipal craft, barge-canal tugs, fish-cannery tenders, oil-tankers and delivery-boats, ship's lifeboats, U. S. Coast Guard lifeboats, Government survey-craft, ferry-boats, etc.

In addition to these commercial boats there are many pleasure boats and yachts which will be equipped with oil-engines. Many owners of large yachts are installing and contemplating installation of oil-engines as against gasoline-engines which cost so much to run.

Let us take as example the U. S. Fishing Industry. The following is an estimate of vessels now engaged in fishing in this country:

New England States

52 Steam Trawlers
60 (estimated) Steam Seiners
808 Motor Vessels
5671 Motor Boats (under 5 tons)
87 Sailing Vessels
4693 Sail Boats (under 5 tons)

Middle Atlantic States

145 Steam Vessels
1767 Motor Vessels
8800 Motor Boats (under 5 tons)
1350 Sailing Vessels
7200 Sail Boats (under 5 tons)

South Atlantic

15 Steam Seiners
190 Motor Vessels
2346 Motor Boats (under 5 tons)
100 Sailing Vessels
3286 Sail Boats (under 5 tons)

Gulf States

207 Motor Vessels
1500 Motor Boats (under 5 tons)
86 Sailing Vessels
4538 Sailing Boats (under 5 tons)

Great Lakes

119 Steam Vessels
384 Motor Vessels
1342 Motor Boats (under 5 tons)
2006 Sailing Boats (under 5 tons)

Furthermore, it is very probable that during the next few years quite a large number of American merchant steamships will be converted to Diesel power. Therefore, in addition to the small-boat field there are, of course, three or four small auxiliary oil-engines on every large motorship. But, without considering these, there is a good demand for oil-engines of small sizes, say up to 400 h.p., that proper advertising and sales efforts—given a really good motor—can turn into orders.

Just as an example of the proportion of small boats of the sizes for which the small engine is fitted, the following record was furnished by the Department of Commerce, giving the number of wood and steel vessels built in the United States and officially numbered during the months January to November, 1921, as follows:

Sailing	44	vessels of		44,686	gross	tons
Steam	225	"	"	1,096,088	"	"
Internal-combustion	541	"	"	35,166	"	"
Un-rigged	213	"	"	49,470	"	"
Total	1,023	vessels of		1,225,410	gross	tons

It will be noted from this table that, while the tonnage of the boats powered with internal-combustion engines is not great as compared with the tonnage of the steam-vessels, practically two and one-half times the number of machinery installations were made in the motor vessels as in the steam-vessels. And it is the number of installations made that interests the manufacturer. Prospects for 1922 are that the small oil-engine is going to be installed in even greater number than in 1921, and activity in several factories indicates that the manufacturer who consistently and persistently goes after business with a really A-1 engine obtains his share. We have before us a report stating that one manufacturer who manufactures an oil-engine averaging 100-150 h.p. has actually on the books and in the shops orders for engines totalling over 2,500 h.p. with more orders being placed each week.

Passenger-freight and towing-boat owned by the Tulalip Transportation Co., Everett, Wash. Propelled by 100 b.h.p. Fairbanks-Morse oil-engine.

Activity at Factory of Small Oil-Engine Manufacturer

Due to Results Obtained in Service—One Pacific Coast Company Has Orders for 2500 H.P.

AS referred to in our November issue, the Atlas Imperial Engine Company's plant is the scene of busy activity. More men are being employed as rapidly as material can be obtained, as the call for full-Diesel power is increasing steadily. The company reports that orders on hand now total over 2500 h.p. and are "still coming." This activity is due to the economical and reliable operation of Atlas Imperial Diesel-engines, among which may be mentioned the following:

The halibut-schooner "Atlas" has just completed a round-trip between Seattle, Wash., and Alaska, immediately following the installation of a 3-cylinder 55 h.p. Atlas-Imperial mechanical-injection Diesel-engine in place of one of their 55 h.p. distillate-engines. This Diesel-engine was the first of this size and type shipped to Seattle and Mr. Peter Wold, owner, and his engineer started out from there for Alaska immediately after completion of a short trial-trip in which the manufacturer's engineer showed them how to operate the engine. The Coolidge type "C" wide-bladed 44 in. diam. by 39 in. pitch propeller, which the distillate-engine had been able to turn to only 290 R.P.M., was installed with the Diesel-engine and turned up to 320 R.P.M. with boat tied to the dock, and at 330 R.P.M. on trial-trip.

Leaving Seattle in the teeth of a severe storm the "Atlas" met heavy weather practically throughout the 4,000 mile trip before returning to Seattle. For part of the time she was weighted down with ice so that her performance is not what it might be under harbor-conditions, but Mr. Wold says that he did not spare fuel or lubricating-oil on account of it being her first trip. She ran a total of 700 hours, including 75 hours running slow-speed on the fishing banks. She used 1,875 gallons of 24 deg. Standard oil and 54 gallons of Calol Diesel lubricating-oil. The total cost of fuel-oil for the trip was $139.50 and for lubricating-oil $18.90, which is about 22.7 cents per hour as against $1.45 which he formerly paid for operating the 55 h.p. distillate-engine for one hour.

The passenger-boat "G W" belonging to the San Pedro Transportation Company is running daily on the San Pedro-Long Beach run, with a fuel-cost of 18 cents per hour for her 80 h.p. 4-cylinder Atlas Imperial Diesel-engine.

The towboat "Halcyon" owned by Capt. E. V. Rideout, powered with a 100 h.p. Atlas Imperial Diesel-engine, is towing barges to and from Pier 19, San Francisco, and Selby's, Mare Island, and Sperry Flour Co.'s wharf, with a fuel-cost per-hour of 33 cents.

The tugboat "Colon" owned by the Oakland Launch & Tugboat Company is now in its eighth month of hard service, towing on the San Francisco Bay. Fuel cost averaging 15 cents per hour. The "Colon" is powered with a 55 h.p. Atlas Imperial Diesel-engine.

The River Freighter "Suisun City" owned by Hunt Hatch Company of Oakland, is on her regular run between Oakland and Sacramento River Points, powered with a pair of 55 h.p. 3-cyl. Atlas Imperial Diesel-engines. Her fuel cost for the two engines, 110 total h.p., is 25½ cents per hour.

The tugboat "Panama" owned by the Oakland Launch & Tugboat Company of Oakland is now at the Atlas Imperial Engine Company's wharf having the 125 h.p. Atlas gas-engine removed and new Diesel-engine installed.

The River Freighter "Lark" owned by Hunt Hatch Company of Oakland has had her 125 h.p. gas-engine removed and the new 150 h.p. Atlas Imperial Diesel-engine is nearly ready.

The 130-ft. pleasure-cruiser building by Cryer of Oakland, Calif., for R. C. Durant will be ready for launching within sixty days and the pair of 140 h.p. 6-cylinder Atlas Imperial Diesel-engines are now being built. This will be an ocean-going cruiser and capable of a trip around the world.

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A New Type of Auxiliary Motor-Trawler

The "Blanche Ring" Runs Trials and Goes Into Commission

THE trend in the fishing industry is toward smaller craft of adaptability to many branches of fishing rather than large boats suited to only trawling, purse seining or line fishing, for instance. By providing a vessel equipped for the various kinds of fishing a more profitable craft is obtained, capable of being operated at all seasons to best advantage. The smaller craft may also be operated by small crews who in many cases own the boat. As ownership in any project by those actually carrying it on is of great advantage the smaller fishing-craft are becoming producers of fish in large quantities at low costs.

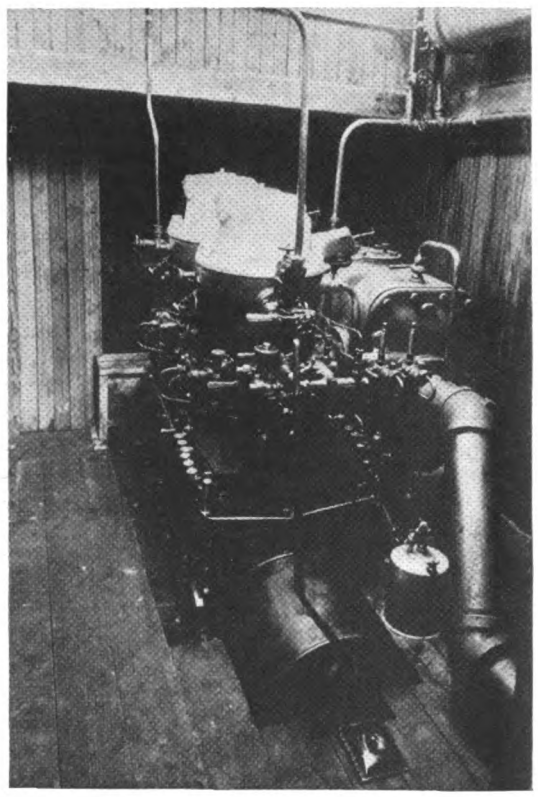
The "Blanche Ring" is a beam-trawler condensed into a length of 78 ft. 6 in. Dragging the ocean for fish has heretofore brought to mind the picture of a big steam-trawler but this impression will now have to be revised to picture a little schooner-rigged craft with a small oil-engine operated by one man instead of the half-dozen on the larger steam craft. Another engineer shares the work of the two-shift day in driving this vessel at 9 knots. She has installed in the center of the engine-room a two-cylinder 100 h.p. Bolinders surface-ignition oil-engine driving a 48 in. by 42 in. Columbian bronze propeller at 325 R.P.M. This is one of their direct-reversible engines and the confidence which the owner and skipper, Capt. Herbert W. Nickerson, has in this is shown by the fact that the trial-trip of the "Blanche Ring" was run on Thanksgiving Day, November 24, 1921, in a bad storm of sleet and snow, the course being on the coast out of Gloucester, Mass., the home of the fisherman.

The principal particulars of the "Blanche Ring" are as follows:

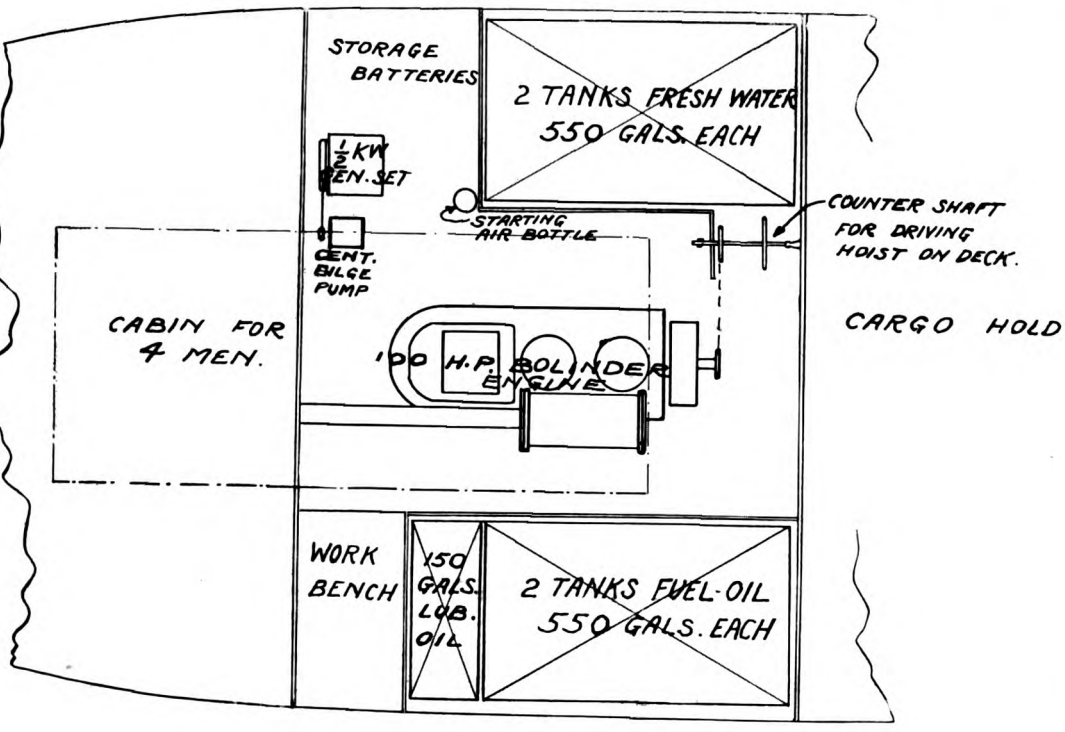
Length over all	78 ft. 6 in
Breadth	20 ft
Depth at main hatch	9 ft.
Draft (loaded)	10 ft 6 in.
Fuel-capacity	1,100 gallons
Cargo-capacity	80,000 pounds
Cost, about	$22,000

The illustration and the plan of the engine-room indicates the simplicity of the installation. In addition to the main engine will be noted a ½ K.W. Fairbanks, Morse electric generating-set, and drive from main engine for a trawl-winch is provided with a Hathaway-New Bedford hauling-clutch installation. Davits for handling the trawl may be noted in the illustration of the vessel taken as she entered Boston harbor after the trial-trip.

The "Blanche Ring" is just the beginning of quite a fleet of such vessels, we believe, for just as surely as the fishermen were skeptical of the oil-engine in the early days they are now enthusiastic. The fishing-fleets form one of best fields for the sale of small marine oil-engines and when such a craft as the "Blanche Ring" is brought out that does not depend upon one kind of fish or one season such a type of vessel is bound to multiply. Manufacturers of the small oil-engine will do well to watch the "Blanche Ring."



Engine-room of "Blanche Ring" showing 100 b.h.p. Bolinder oil-engine.


STORAGE BATTERIES
2 TANKS FRESH WATER 550 GALS. EACH
½ KW GEN. SET
STARTING AIR BOTTLE
COUNTER SHAFT FOR DRIVING HOIST ON DECK.
CENT. BILGE PUMP
CABIN FOR 4 MEN.
100 H.P. BOLINDER ENGINE
CARGO HOLD
WORK BENCH
150 GALS. LUB. OIL
2 TANKS FUEL-OIL 550 GALS. EACH

Engine-room plan of the "Blanche Ring"

Fishing-Schooner Blanche-Ring on trial trip

Why Oil-Engines Are Not Yet Used

THE Saunders Fish Company of Pensacola, in spite of the growing popularity of heavy-oil and gasoline engines with many of the Gulf fishermen, still finds the sailing-vessel the most satisfactory craft for its great red snapper business, the value of which reaches millions annually, and is the chief source of revenue of the Pensacola company.

The Saunders Company has never operated its fishing-vessels with auxiliary engines, but when the Pensacola Shipbuilding Company, in which Mr. Frank E. Welles, president of the Saunders Company, was interested, built the auxiliary sailing-vessel "Palafox," twin 100 b.h.p. Fairbanks-Morse oil-engines were installed. This 550 tons vessel was built for Cuban trade, but after the engine had been installed, owing to the regulations that auxiliary vessels of such tonnage must be operated by a regular steamship crew, the engine was taken-out, and the vessel was converted into a barge, as it was found that operating the ship under such conditions was too costly.

The only engines used by the Saunders Fish Company are the hoisting-engines on the decks of the fishing-smacks.

The only boats operated with the engines are the "Ching" boats, which work along the coast, not venturing far into the waters of the Gulf.

The average size of the vessels owned and operated by the Saunders Fish Company, is about 108 tons gross. These vessels are 97 ft. long by 24 ft. beam and 13 ft. deep. They are schooner rigged, with suit of sails consisting of foresail, mainsail, jumbo jib, jib, jib topsail, storm trysail, and riding sail, used in heavy weather. All vessels are equipped wtih hoisting-engines to handle sails and anchor. The crew accommodations in the forward part of the vessel have space for eight to twelve men, and the Captain's quarters, aft, accommodate from four to five men, with sufficient room for lockers, storage of extra ropes, etc. The galley is just aft of the crew's quarters forward. All these vessels, of which there are nineteen, are equipped with cork insulated ice-boxes, sufficient in size to store thirty tons of ice. In the crew are nine men, besides the Captain.

They are built for rough weather, as they go sometimes six or seven hundred miles, in search of their haul. The vessels are docked at least three times a year, and painted with copper paint, to keep the worms from destroying the bottoms of the vessels. Sometimes these boats will bring in 60,000 pounds of fish in one catch.

The vessels cover a great deal of ground on a trip, as the fishing bank is not reached until 300 miles from Pensacola, and then the vessels fish on down until they reach the Caribbean Sea. The men who do this deep sea fishing are more familiar with sail-boats than with engines, and this, together with the fact that it is less expensive to operate a sail boat than one under motor power, has led the Saunders Company to continue the use of sails, which have proven entirely satisfactory for deep-sea fishing.

Steps should be taken by oil-engine builders to show the gain that can be effected by the use of efficient oil-engine propelling and ice-making plants.

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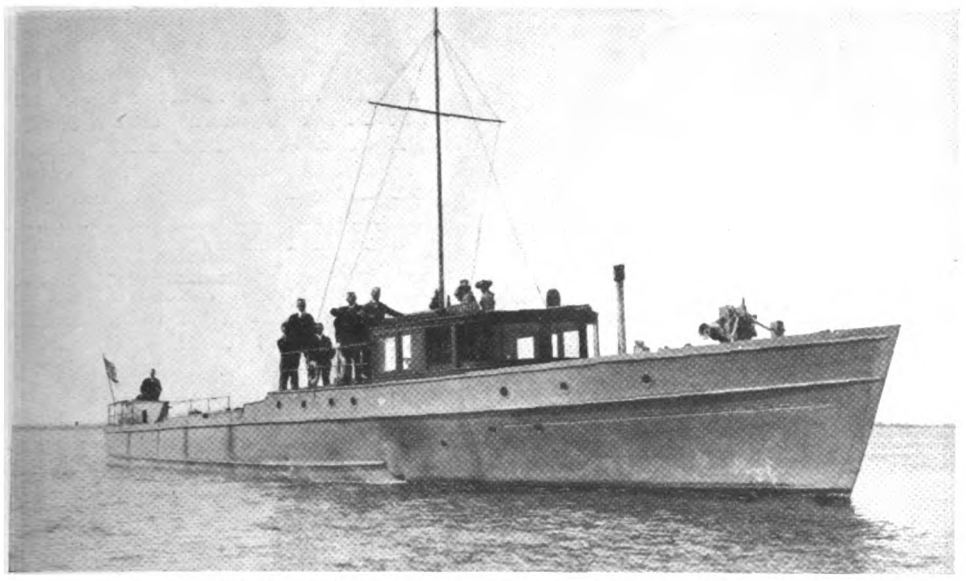


"Butterfly" a Dodge-engined sardine carrier

ECONOMICAL SARDINE-CARRIER "BUTTERFLY," FORMERLY A GASOLINE-YACHT

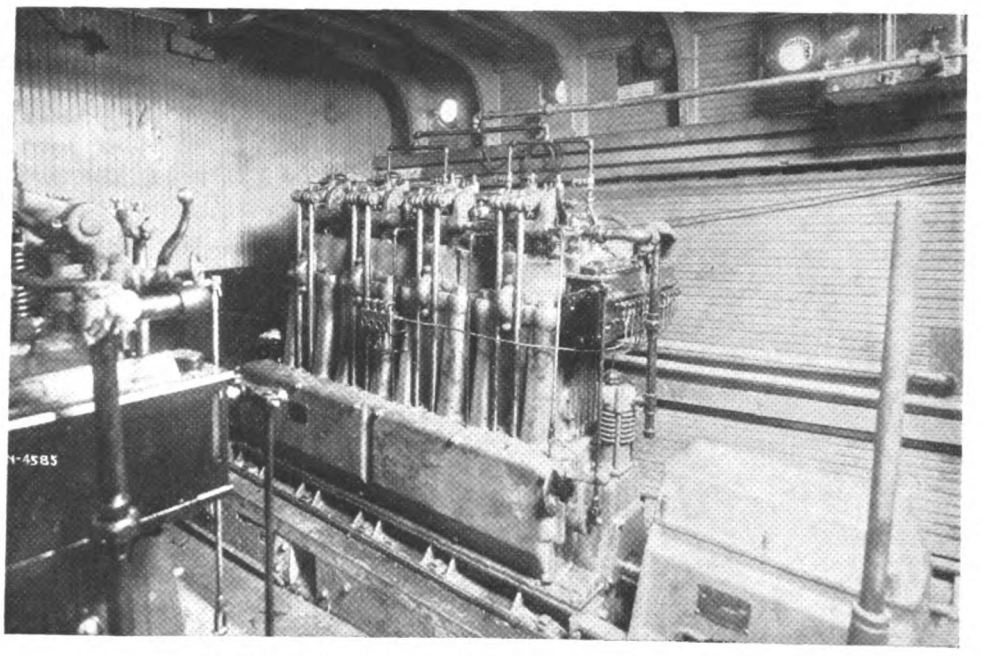
Economy of operation and dependability of heavy-oil engines has been strongly evidenced in the installation of two 50 h.p. two-cylinder Dodge-engines installed in the fishing boat "Butterfly." This boat is ninety-two feet long with twelve feet beam and draws about four feet. For a considerable period now the boat has been driven on long runs daily and has been running on the average of seventy-five hours a week. The Lawrence Canning Company, who are large packers and dealers in sardines at Rockland, Me., state that the installation has given entire satisfaction. The fuel-consumption is unusually low as each engine is only consuming about three and one-half gallons of kerosene an hour. Fuel-oil has not been used in these engines because of lack of storage facilities.

The performance of the engines is featured by absolute lack of vibration and cleanliness which the owners state they have never experienced in any other engine of heavy-oil type. Both engines run without smoke, thus proving perfect combustion.

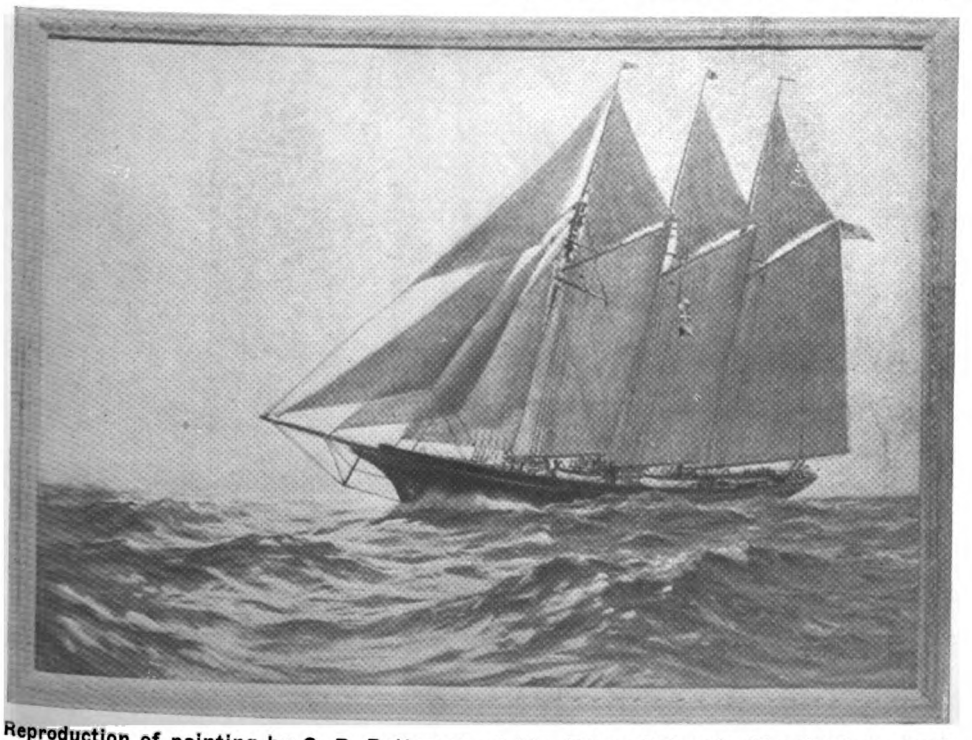
The "Butterfly" is undoubtedly one of the finest sardine-carrying boats on this coast, and the Lawrence Canning Company indicate their absolute and complete confidence in the installation by sending this boat after fish to points where they have never dared send any of their other many boats. The builders of the engine advise us that the installation has resulted in a large number of inquiries from this point where the performance of these engines has attracted so much favorable comment. At present there seems to be every indication that in the next few years a large percentage of fishing craft will be heavy-oil engine equipped.

DIESEL YACHT ON LONG CRUISE

The 110 ft. Diesel-yacht "Centaur," formerly the "Swastika" ex-"Aeldgytha," now owned by Glenn Stewart, started from New York about the middle of November on a cruise through the West Indies, Panama, etc., which will occupy several months. Two 180 b.h.p. Craig Diesel-engines drive the "Centaur" at 11 knots speed on a consumption of only 10½ gallons of oil. The economy of the Diesel-yacht is making possible extensive cruises that would be prohibitive with a big gasoline yacht.



Dodge-engines in the sardine carrier "Butterfly"



Reproduction of painting by C. R. Patterson of Mr. Edgar Palmer's Diesel-driven auxiliary yacht "Guinevere" published by courtesy of the owner and artist.

AN IMPRESSIVE SIGHT

When the Italian warship "Libia" recently left Italy on a voyage around the world, over one-hundred motor fishing-boats gave her a "send-off" escorting her for some miles out of port. We saw this most impressive sight on the Fox News Weekly at the "movies," and it was one of the finest animated sea-photographs we have ever witnessed. Incidentally it gave an insight to the remarkable progress of the oil-engine in Italian fishing-boats, made since the war with the assistance of the Italian government.

LAUNCH OF MOTOR-VESSEL FOR INDIAN SERVICE

"Murabek," a single-screw motor coastwise vessel, recently carried-out satisfactory trials in Scotland. She was built to the order of the Bombay Steam Navigation Company, at the London & Montrose Shipbuilding & Repair Company, Montrose.

She is 132 ft. long, of 25 ft. breadth and 12½ ft. draught and is propelled by a 200 shaft h.p. Beardmore surface-ignition oil-engine, giving her a speed of 8 knots.

ACTIVITY IN THE AMERICAN MOTORSHIP FIELD

During recent weeks very considerable activity has evinced itself in the marine oil-engine and motorship industries, bids on a number of vessels and machinery sets having been asked for. One job not yet mentioned in "Motorship" is that of a twin-screw Diesel installation in conjunction with the Kitchen reversing-rudder for a 1,000 tons 18 knot commercial vessel. Also a similar installation on an old destroyer now located at New London, Conn., which will be turned into a motor freighter by private interests. These we hope will result in orders being placed. From all sides come encouraging reports of prospective business for motorship and oil-engine builders including a number of conversions from steam to motor power.

NEW FISHING SCHOONER FOR O'HARA BROS. CO.

In our November, 1921, issue we published illustration and description of the auxiliary fishing schooner "Pioneer" owned by O'Hara Bros. Co. of Boston, Mass. Since last July, when the Bolinder oil engine was installed, the "Pioneer" has performed so creditably that the owners have ordered one of the new type two-cylinder 100 h.p. Bolinder direct-reversible engines to be installed in a new schooner building by Arthur D. Story at Essex, Mass. This vessel will be 103 ft. length over all, 89 ft. water line, 22 ft. 9 in. breadth, depth 9 ft., draft 12 ft. 3 in., and will register 110 gross tons. A Columbian bronze propeller of 50 inches diameter will drive her at 8 knots.

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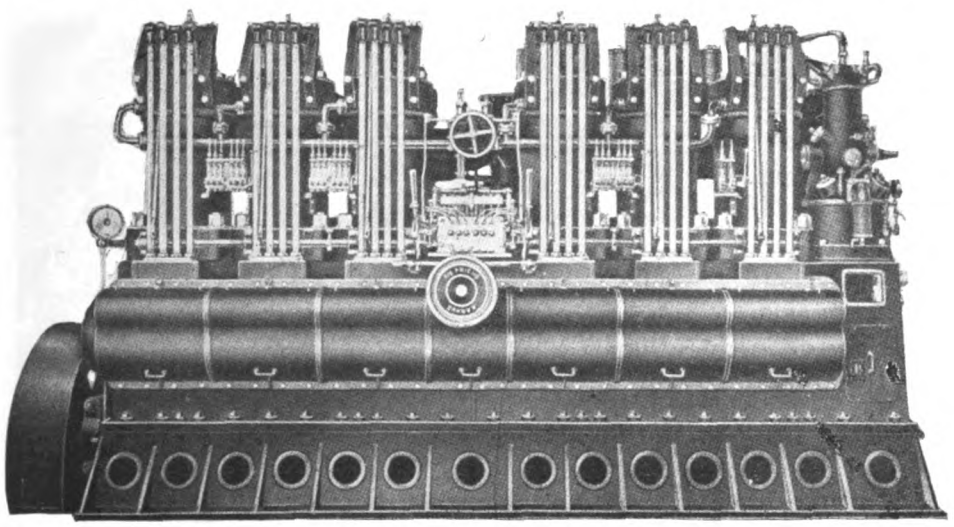
Diesel Engines for Coastwise Craft

Interesting Example of Type of Machinery Built in Denmark for This Class of Vessel

ALONG the immense coast line of this country there are operated a great fleet of vessels of many types, including fishing, oyster-dredging, passenger, ferry, general-cargo, oil-carrying, coal-transportation, harbor-service, and other various craft too numerous to mention. This fleet is ever increasing. These vessels are of moderate dimensions and utilize the power developed from thousands of gasoline, steam and oil-engines of 20 to 2,000 h. p. In this field there is great opportunity for the manufacturer of internal-combustion heavy-oil engines; it is, in fact, in that fleet of medium-sized craft that their greatest opportunity lies, for to one vessel of ocean-going size there are a score of smaller ones that are indispensible in our shipping and whose activities make it possible for the bigger ship to operate. This tremendous market for marine-oil engines is ever-present; unlike the field for large installations, which—comparatively speaking—are made only occasionally, these smaller engines are being installed constantly; therefore, American manufacturers of motors up to 500 or 600 h. p. or thereabouts, should study this field very carefully, not only direct-drive but the possibilities of Diesel-electric and reduction-gear installations as well.

In European waters the use of heavy-oil engines in coastwise fleets has become very large and engine manufacturers have gained much experience in installations of various types. This experience as embodied in their products and work is of certain value to American manufacturers. So some information regarding a typical Danish coastwise motorship installation may be of considerable interest.

Frichs-Engined Concrete Motorship "Poseidon"



The Frichs four-cycle Diesel type 400 shaft h.p. marine engine

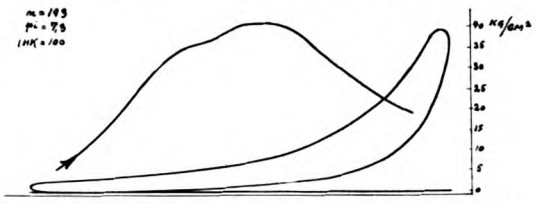
The accompanying illustration of the Danish coastwise vessel "Poseidon" shows a typical cargo ship of 2,300 tons displacement, 1,300 tons D. W., 198 ft. long by 33 ft. breadth and 18 ft. 2 inches depth, built of concrete by Saigon Codan shipyard, Koge, Denmark, for the Triton Shipping Co., Copenhagen, Denmark. She is powered with one one of the first 400 h.p. reversible four-cycle Diesel engines manufactured by A/S Frichs, Aarhus, Denmark, a firm well-known in their country for the manufacture of steam and Diesel stationary and marine machinery.

In the "Poseidon" are installed, in addition to the main engine, a two-cylinder 35 b.h.p. Frichs Diesel-driven auxiliary compressor which supplies air for starting at 25 k.g. (55 lbs.) pressure per sq. in. or injection-air at 70 Kg. (154 lbs.) per sq. in. as required at full load, a ballast donkey-pump of 20 tons capacity and 3 deck-winches operated by means of belt drive to countershaft in the engine-room driving shafting on deck. In the engine-room there is one tank for the starting-air, three tanks for injection-air for the main engine and one for the auxiliary motor, daily-service tanks, filters for fuel-oil and lubricating-oil, and three oil-tanks totalling 40 tons, one forward of and two aft of the engine. The thrust-bearing is of the ball type running in an oil bath, while the stern-tube is white-metal bushed and fitted with inside and outside Cedervall stuffing-boxes. The propeller is of the 4-bladed cast-steel type, whereas most American craft of this size have bronze propellers.

On brake-test the maneuvring ability of this 400 h.p. Frichs Diesel-engine was very satisfactory, and during a four-hours run at normal load an output of 545.3 i.h.p. or 408.8 b.h.p. was developed on a fuel-consumption of 183 grams (0.403 lb.) per b. h. p. hour. As the engine was driving, during this brake-test, a cooling-water pump of 10 tons capacity and 10 tons bilge-pump in addition to the air-compressor, the mechanical efficiency of 74.9% must be considered very good for a six-cylinder engine of this size. The accompanying indicator-card was taken on test at 193 R. P. M.

Further description of this engine is interesting.

In order to provide space in the frame for the camshaft gear, maneuvring and fuel controls, the cylinders of the main engine are arranged in two sets of three with controls between, the direct-driven air-compressor and the fly-wheel being mounted at forward and aft end of the engine respectively. In order that this engine can be installed on foundations exactly as steam-engines are installed, the cast-iron bed-plate with cast-steel main-bearings lined with white-metal is mounted on an oil-tight base. Connected with a flanged clutch is a two-piece crankshaft with six crank-throws of 60 deg. each, while at the forward end is an overhanging crank arm driving the air-compressor. Working-pressure on the pistons is taken up by four through-bolts, located close to the main-bearings, uniting each cylinder with the base, the two-piece engine frame, which has removable inspection-plates, being relatively light and intended principally to enclose and protect the working parts. Separate cast-iron cylinders

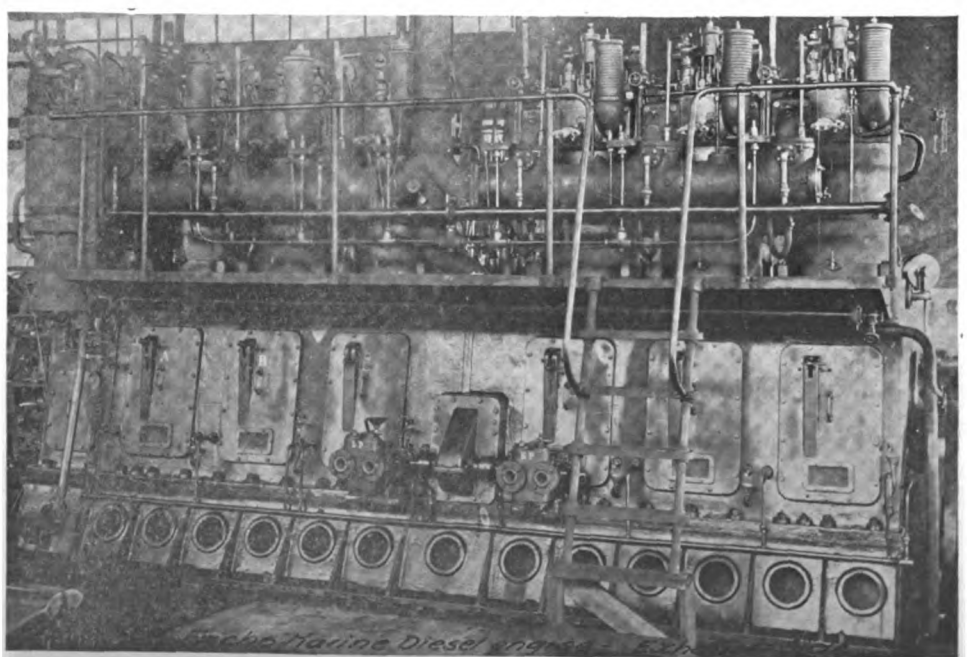


Indicator-card taken from Frichs marine Diesel engine

are provided with removable liners effectively cooled as will be noted on sectional view. Up to 700 h.p. the Frichs engine is built with trunk pistons, but above that size they are of the cross-head and guide type.

In the cylinder-heads are arranged vertically the four valves i.e. fuel, air, exhaust and air-starting, while the relief-valve is mounted vertically on the side of the cylinder heads. The air intake is provided with a patented silencer and the horizontal exhaust-manifold is water-cooled. The air-compressor is of the vertical single-acting 3-stage type, with silent valves; air is cooled between stages before being led to the tank.

Lubrication of the main-bearings, etc. is effected by force-feed from a rotary oil-pump driven by the crankshaft, the oil being cooled and filtered, but the pistons are lubricated by special force-feed pump mounted on the cylinders near the maneuvring controls, this pump being operated by push-rods, with filters and sight-feed gages for each lubrication point. Cast integral with the engine-frame are bearings provided with adjustable bronze-bushing under force-feed lubrication for the camshaft A, all cams running in oil bath.



Back view of Frich's 400 b.h.p. marine Diesel-engine

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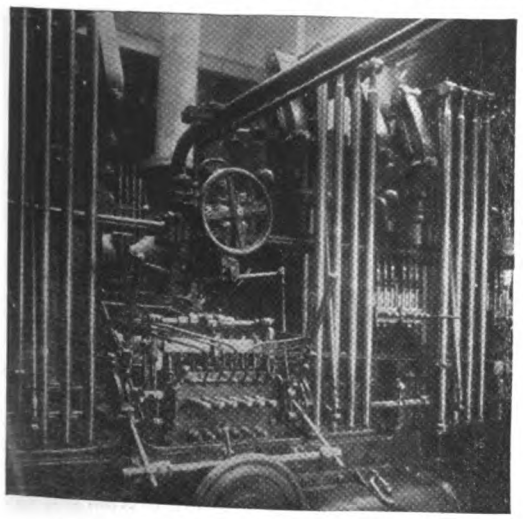
The camshaft is gear-driven from the crankshaft and is provided with one ahead and one reverse cam, reversing being effected by moving the reverse-shaft E (operated by worm-gear from the reversing-wheel), forward or aft to engage rolls C. and D, which are provided on the bottom movable part B of the push-rods for actuating the valves. The starting-valves G are engaged and disengaged by two levers H and pull rods I. The fuel-pumps K, one for each cylinder, are driven by two eccentrics L and the rocker shafts M from the intermediate shaft N. Their capacity is regulated by the two levers O operating the suction-valves. The wheel F and the levers H and I are combined so that it is impossible by a wrong maneuver to engage the starting and the fuel-pumps at the same time. Not until both have been disengaged can the wheel be moved and reversing take place. During maneuvring, pressure is reduced in the cylinders by a simple arrangement opening the exhaust-valves. In the rocker C that follows the movements of the fuel-pumps the emergency governor is mounted, this automatically opening the fuel-pump suction-valves when the R. P. M. exceed 10% of the normal figure. A tachometer is provided.

Our Danish correspondent has estimated the saving effected by the motorship over a steamship based on costs in that country with the following result: On account of the extra weight of hull of the concrete-vessel over that of a steel-steamer the "Poseidon" having a displacement of 2300 tons and a deadweight-capacity of 1,300 tons should be compared with a steamer of 2,300 tons-displacement, which would be of about 1,650 tons-deadweight. Such a steamer has not as large cubic-capacity as the motorship, which has 65,000 cu. ft. while the weight of the Diesel-engine installation is little more than half that of the steam-installation; therefore the difference in deadweight-capacity is clearly due to the concrete-hull of the motorship. Actual figures covering the weight of the Diesel-engine installation are as follows:

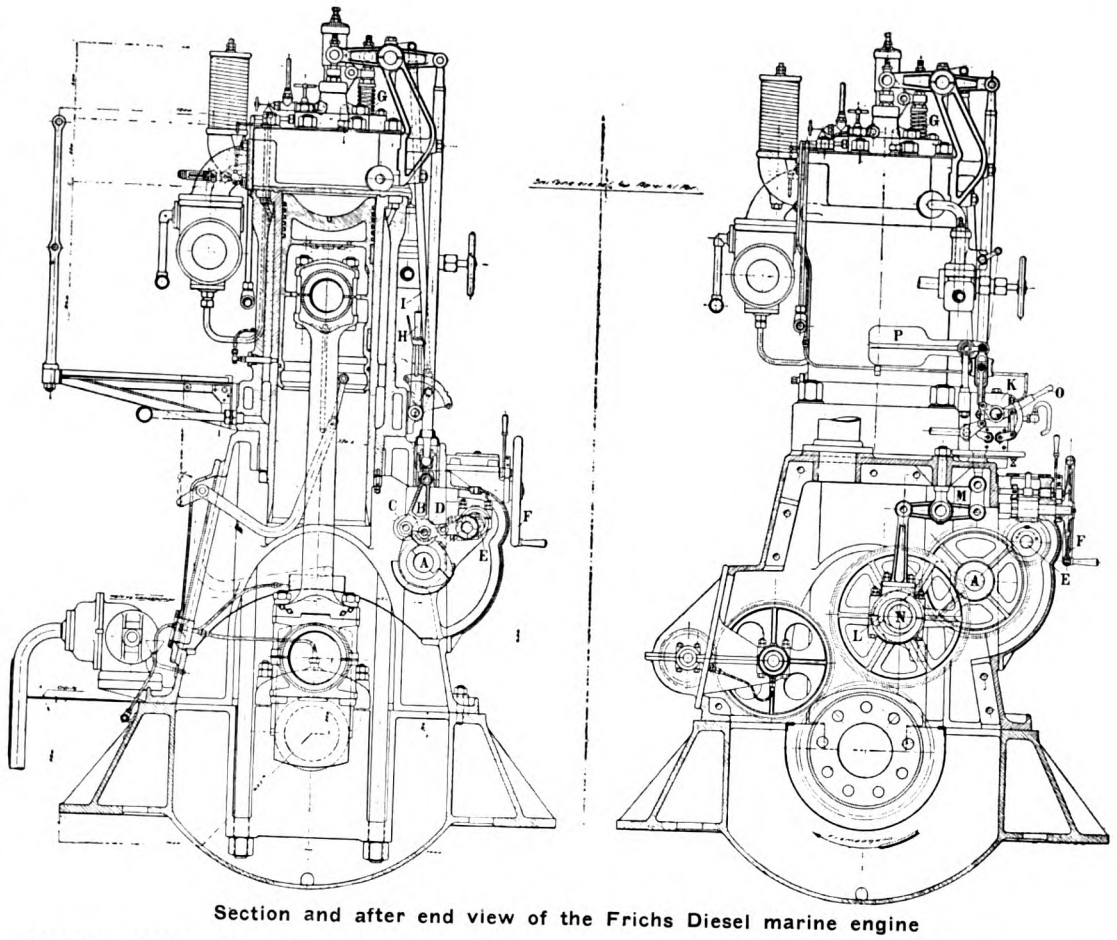
Main-engine	41.5	metric tons
Auxiliary-engine	6.7	" "
Shafts and stern-tube	5.0	" "
Tanks, piping, valves, etc.	9.0	" "
Total	62.2	metric tons

As against a fuel consumption of 1:66 tons of fuel-oil per 24 hours in the motorship, the steamer would consume about 8 tons of coal, both ships making the same speed. Coal in Denmark at the time of writing was Kr. 55 while oil was Kr. 165 per ton so that the fuel-costs work out at Kr. 0.38 and Kr. 0.82 for the motorship and steamer respectively, or a saving of 40 per cent in favor of the motorship.



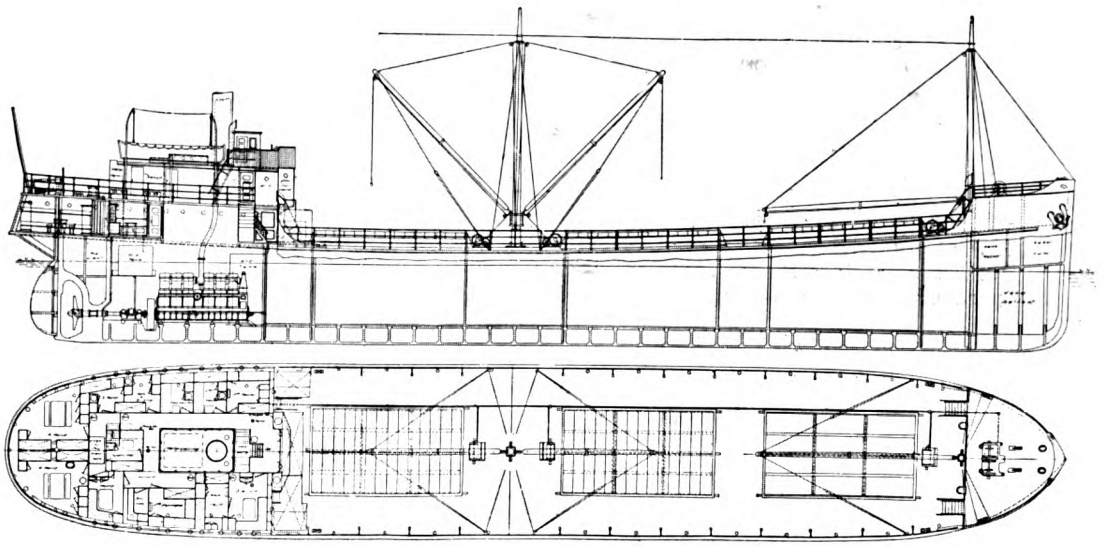
Controls of the Frichs Diesel engine

Both the "Poseidon" and the "Triton" have been in constant service, but the latter vessel unfortunately ran ashore off the Norwegian coast and became a loss through no fault of the machinery but because the pilot was below asleep. The "Poseidon" is owned by a shipping company which also owns a concrete steamer, which however is laid-up, and Torben Nielsen, managing director of the firm, recently stated that "it would have been impossible to keep a steamship of similar size in operation during this slump period in shipping at the rates to be obtained."



Section and after end view of the Frichs Diesel marine engine

An excerpt from the engineer's log of "Triton" is interesting as proving economy in actual service, where the engine runs at a normal output of 400 b. h. p. The mean fuel-consumption per brake horsepower hour is 0.173 Kg. (0.381 lbs.), which means a fuel-consumption per 24 hours of 1.66 tons at a speed of 7½ knots. Owners of steam-driven cargo-vessels of 1,300 tons D. W. capacity should sharpen their pencils and see what it costs them in fuel to carry 1,300 tons of cargo each 24 hours at this speed, then add the stand-by expense, the boiler repairs, the cost of strikes and troubles with firemen and coal passers, and see how much of their profits they are burning-up in boilers. Then add to this cost the loss of cargo capacity they suffer by allowing that wasteful boiler and its feed-water to occupy space which should be used for profitable cargo and they cannot help but see why the medium sized cargo-motorship gains such ground.



Plans of the motorship "Poseidon"

THE AMERICAN KRUPP SYSTEM-DIESEL ENGINE COMPANY.

This company during December, perfected arrangements with Messrs. Fried Krupp, A. G. Germaniawerft, Kiel, Germany by which it becomes again the sole representative in the United States, its possessions, Canada and Mexico for the sale of Krupp Diesel Motors, air-compressors, and auxiliaries. The American Krupp System-Diesel Engine Company, was organized in 1913, to take over the sole rights, license and sale of the Krupp Motors in the United States and its possessions, but owing to the European war it was unable to carry out this program.

During the period of the war the Krupp works developed numerous types of Diesel-engines, and have made vast strides in the industry, accomplishing the standardization of practically every type and are now actively engaged in turning out all sizes of both marine and stationary engines, and which are ready for immediate delivery in powers of from 45 to 2,000 shaft horse-power.

WHILE A THOUSAND AMERICAN SHIPS ARE IDLE

We understand that the Danish Diesel-driven motorship "Chile" has been chartered to load a full cargo of lumber at Seattle for the Orient.

STOCK COMPANY TO BUILD AUXILIARY SCHOONERS

According to advices from Bangor, Me., parties at Eastport are forming a stock company, which plans to engage in the coastwise freight business with a fleet of half-a-dozen auxiliary motor schooners of about 80 tons each, to run between Boston, Portland, and Eastport, stopping at various intermediate ports. The boats will be built in the Pushee Yards at Dennysville, Me.

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Ferry for Service Between Norway and Denmark

Diesel Powered New Twin-Screw Vessel of 6,000 i.h.p.

FROM our Copenhagen correspondent we have received copy of the report from the Danish Railroad Commission on the question of the proposed train and passenger ferry connection between Norway and Jutland (Denmark). The report recommends the adoption of a twin-screw Diesel-driven ferry vessel, and reads as follows:

"The requirements for this ferry, which has to cross the open sea in 5-6 hours, and often during winter time, may meet with very rough weather, will not be fulfilled by a ferry with steam-engines, and as the Diesel motors designed nowadays are fully as reliable and much more economical than any other machinery, we recommend twin-screw Diesel-motor driven ferry.

"The deck space on such a ferry may be much better utilized, owing to the absence of smoke stacks, and in such a motor ferry 3 tracks easily can be arranged. The motor ferry will not use any fuel-oil when in port, while a steam-driven ferry must constantly keep steam and uses about 35% of the total consumption in port. The economy while at sea for the Diesel ferry is so evident, that we hardly need mention this point. Bunkering fuel-oil is quick, clean and easy, and the manoeuvring of the motors is fully as rapid as with steam engines. The engine crew will be greatly reduced because firemen will be eliminated. The speed of the new ferry should be 16 to 16½ knots, and the motors be of such dimensions that they can keep this speed even in rough weather."

The passenger trains, including the locomotive, are run directly onto the ferry, and the passengers may remain in the train or walk about on the outside decks at their leisure.

Burmeister & Wain of Copenhagen, have submitted a proposal for this ferry, which we understand has been accepted, and on account of the rough service which the ferry will be exposed to, they have proposed to build the ferry with full lines, and scantlings in excess of the Classification Society's rules. The accompanying illustration gives the main features of the proposed ferry. The tracks are placed lower than the main deck, so as to allow the passengers to step direct from the floor of the cars to the deck.

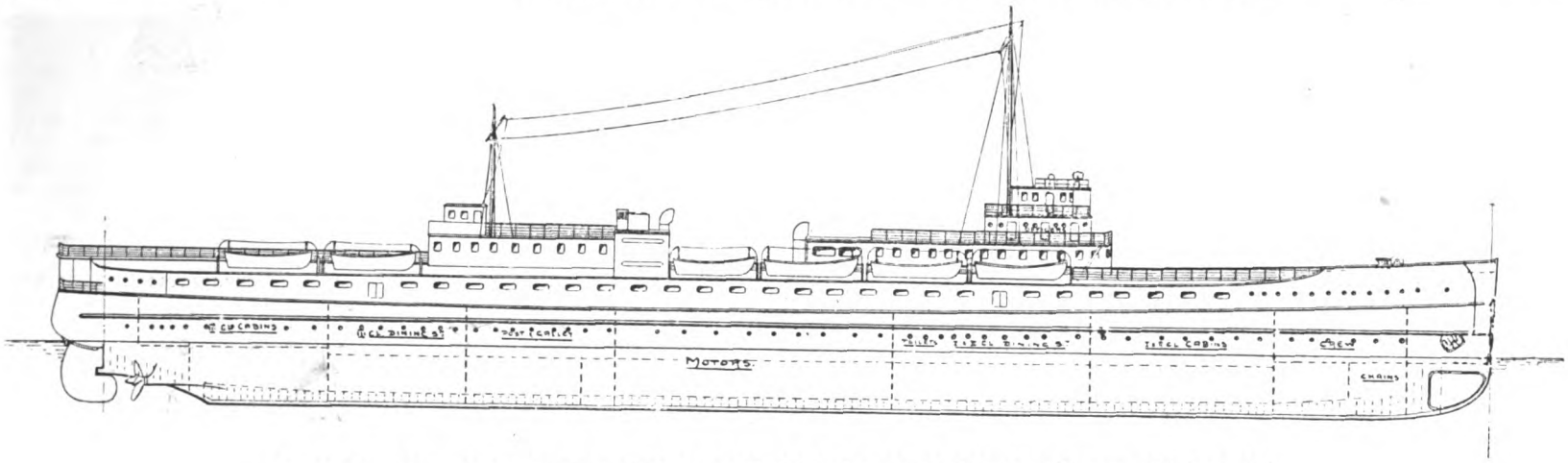
In the superstructure of the ferry is fitted great light openings with windows of thick glass, so that the passengers in their cars have an unobstructed view from their seats. The cars are perfectly protected as they stand in the fully closed super-structure. Numerous doors lead from the track platform to the deck outside the superstructure. The trains can only enter from the forward end of the ferry and the bow is arranged with a bow gate (which can be swung open) of similar construction as in other Danish ferries. There is no entrance from the trains aft, the vessel being built with "cruiser stern." The ferry has to swing round after leaving each port, and when it enters the port it always comes in forward end to the ferry landing. When it leaves port, going astern, the large forward rudder fully takes care of the necessary manoeuvring.

The main dimensions of the ferry are:

	Meter
Length between P. P	115
Breadth over fenders	17.5
Depth	8.5
Draft	5.0
I. H. P.	6,000
Effective length of tracks	275

The staterooms for passengers, who are not traveling within the train, are situated on the main deck, and a total of 1,000 passengers may be accommodated. Her machinery will consist of twin 3,000 i.h.p. Diesel motors and the necessary auxiliaries, which supplies electricity for all the various services on board the vessel. The total fuel-consumption for 1 trip of 100 miles is 6¼ tons, at an average speed of 16½ knots. For heating purposes, an oil-fired donkey-boiler is to be installed.

The above is quite indicative of the progress in motorship building and in the use of Diesel-engines in the Scandinavian Countries (to which oil must be imported from U. S. A.). American Railroad Companies should consider the introduction of Diesel power in the numerous train ferries and passenger ferries in this country, where fuel-oil is right at hand.



Diesel-driven ferry to be built by Burmeister & Wain for service between Norway and Denmark

MOTORSHIP "LASSEN" BEING FITTED WITH TWO NEW TAIL-SHAFTS

At the yard of Barnes & Tibbitts, San Francisco, the 700 gross-ton auxiliary schooner "Lassen" which has two 240 h.p. Skandia oil-engines, is in dry dock being fitted with new tail-shafts.

SEA-TRIALS OF THE "SCOTTISH MAIDEN."

At the end of November the new 10,050 tons deadweight motor-tanker "Scottish Maiden," ran her sea-trials. She has been built by Vickers Ltd., for Tankers Ltd.

THE NOBEL ENGINE.

Owing to pressure on space we have been obliged to again hold over the diagrams of the Nobel merchant-marine Diesel engine, referred to on page 986 of our December issue. They will be given in our February number.

HOLLAND'S LARGEST MOTORSHIP STARTS ON MAIDEN VOYAGE

The Rotterdamsche Lloyd's new motorship "Kedoe" sailed from Rotterdam on November 30th for Java on her maiden voyage. She was illustrated last month on page 971 and it will be remembered that her hull and machinery were built by Burmeister & Wain. Her main dimensions are: 382 ft. length overall; 367 ft. B.P., breadth, 51 ft., 3 in.; depth, moulded 34 ft.; draft, 23 ft., 2 in.; displacement, 9,800 tons; dead-weight, 6,500 tons; capacity oil fuel tanks, 1,220 tons; machinery, twin Diesel motors of 1,300 I.H.P. each, which give the ship a speed of 12 knots. Her neatly furnished accomomdation gives room for 12 passengers.

The "Kedoe" is of the shelterdeck type, having 3 masts with double derricks and 4 five-tons and 6 three-tons electric winches. On deck are placed a double-electric capstan and an electric windlass, while the steering engine is of the hydro-electric type controlled from the bridge by telemotor and is placed on the poop. The bore and the stroke of the two main Diesel engines are 590 mm. and 900 mm., respectively, and are of the four-cycle type.

When loaded the ship is expected to have a speed of about 11½ knots at 130 R.P.M., with a daily fuel-consumption of 9 tons, so that a total distance of approximate 37,000 nautical miles can be covered on one bunkering. The three auxiliary motors, which are on the port side are each coupled to a 50 KW. 220-volt electric-generator. A vertical boiler is placed in the tunnel-recess, which will be chiefly used for steam-heating purposes. This boiler also supplies steam for an emergency air-compressor.

During the trial trip and the voyage from Copenhagen to Rotterdam the auxiliaries were tested out and found in good working condition, and as a whole both trips have been declared to be very successful and satisfactory to the owners. On the trial trip the measured mile was averaged at a speed of 12.45 knots at 141 r.p.m. developing 2,700 I.H.P., the fuel-consumption being 138.5 grams per I.H.P. hour.

FIVE NEW DIESEL-ELECTRIC CANAL CRAFT

Plans and specifications are now being prepared by R. R. Livingston, 2 Rector Street, New York for five 500 tons carrying-capacity packets to ply between Buffalo and New York City. Two Diesel-engines of about 260 h.p. will drive electric-generators, these in turn driving two motors coupled to propellers. This fleet will cost about $500,000 and will probably be completed about May, 1922. The length will be 160 feet. Considering the ease and reliability of control of Diesel-electric drive and the great amount of manoeuvering necessary with craft passing through the Canal this drive should be well suited to the work. We hope to give further details at a later date.

NEW DIESEL-YACHT

A motor-yacht, which will be able to navigate all of the principal canals of the country, is being built for Alfred I. DuPont, of Wilmington, Del., at the plant of the American Car & Foundry Co. in that city. The yacht, to be completed by February 1, will be slightly less than 100 ft. overall, about 18-ft. beam and of only 4-ft. draft, with a tonnage of 120. She will have a double-bottom and will be powered with a pair of Diesel-engines of 125-h.p. each, a separate electric light plant, a steam-heating plant, refrigerating system, etc.

Mr. du Pont states that he built the yacht for real sport, his steam yacht "Alicia" being too big and cumbersome, and requiring a large crew. The new yacht was designed by Edward R. Carroll, a Camden engineer.

ANOTHER NEW WINTON-DIESEL MOTOR YACHT

Now completing at the works of the Herreshoff Mfg. Co., at Bristol, R. I., is a palatial motor yacht about 175 ft. long for E. B. Dane of Boston, Mass., in which two six-cylinder 350 h.p. Winton Diesel-engines are being installed. Further particulars will be given later.

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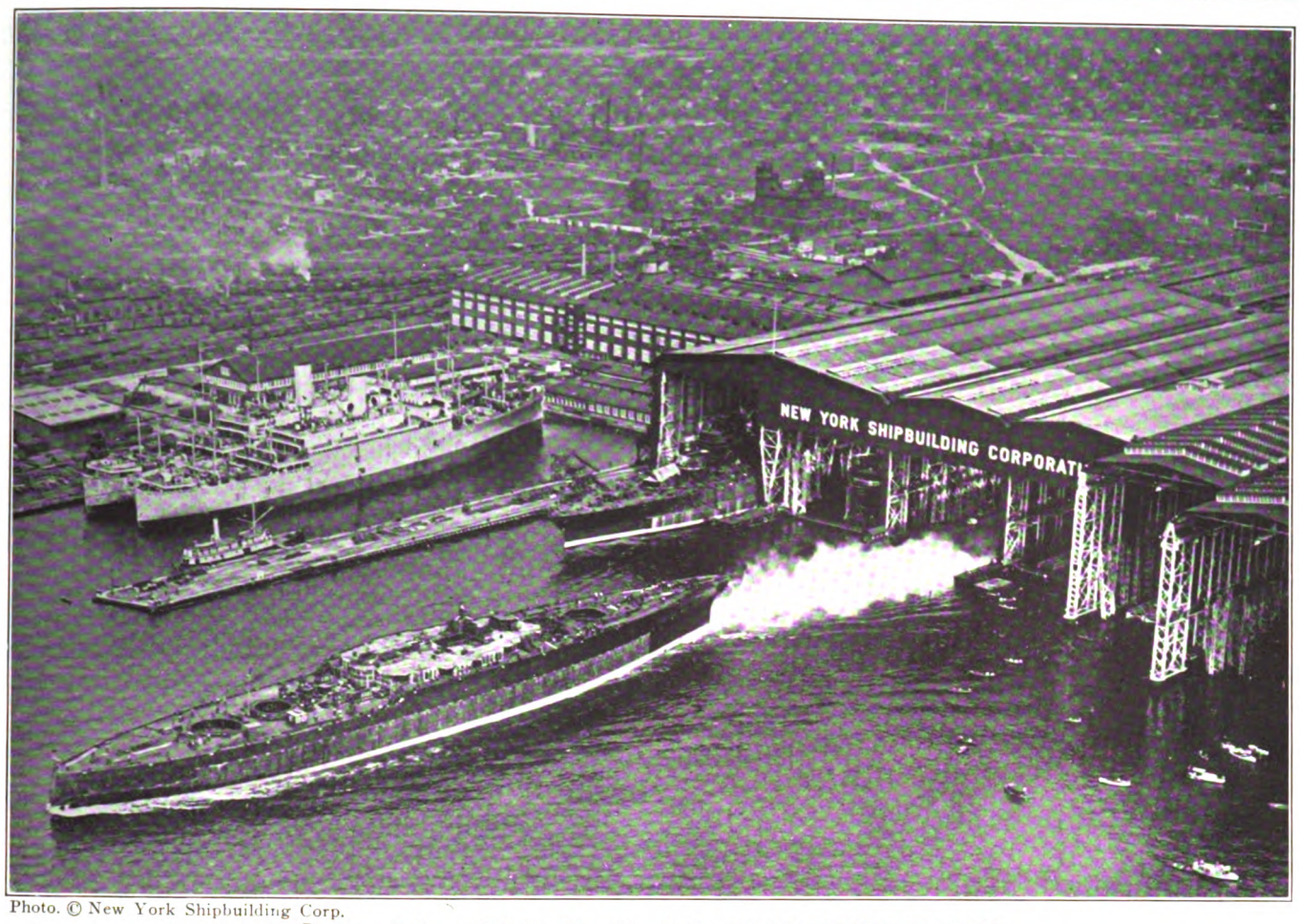

Photo. © New York Shipbuilding Corp.

Launching U. S. Battleship "WASHINGTON"

NEW YORK SHIPBUILDING CORPORATION

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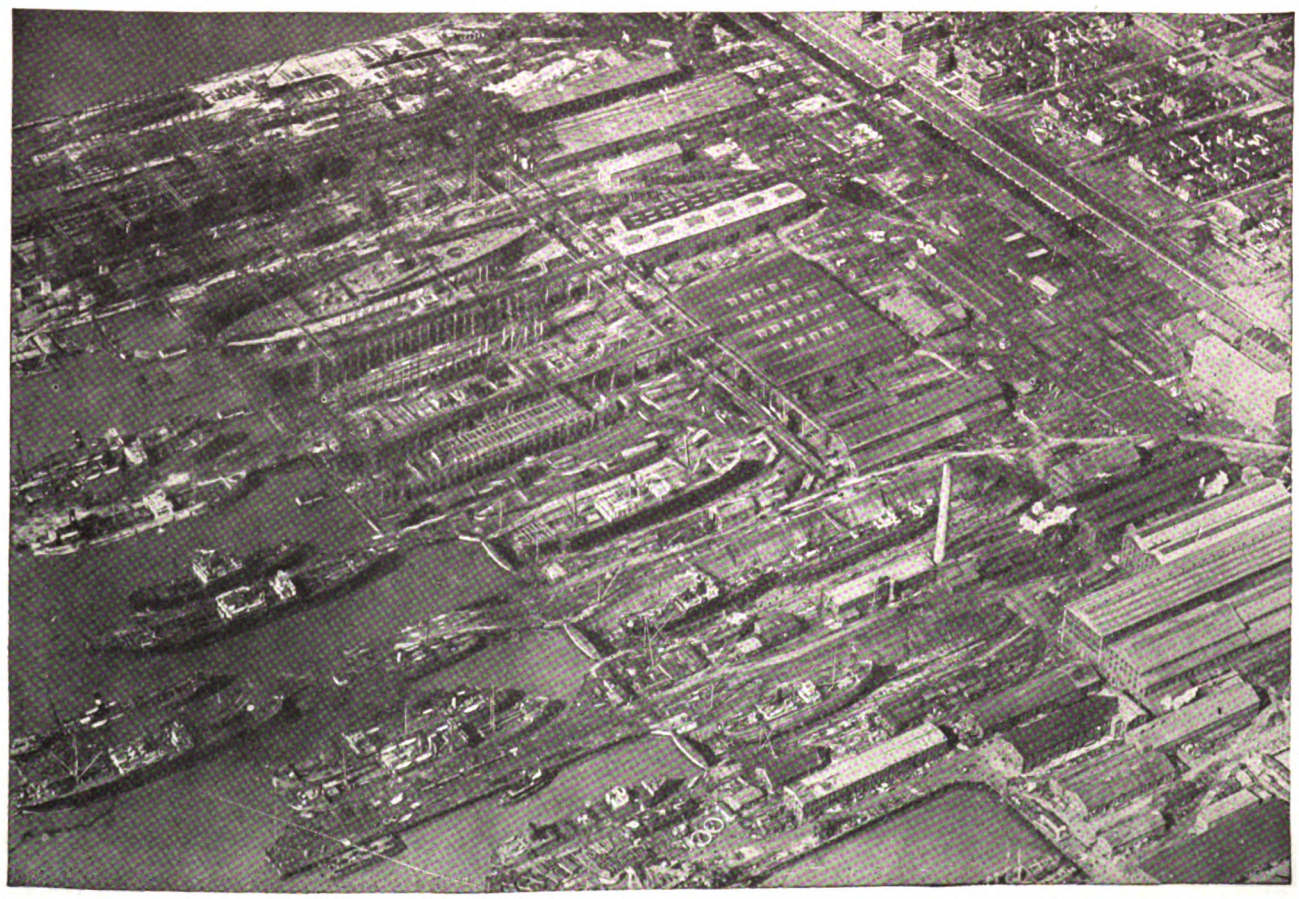

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